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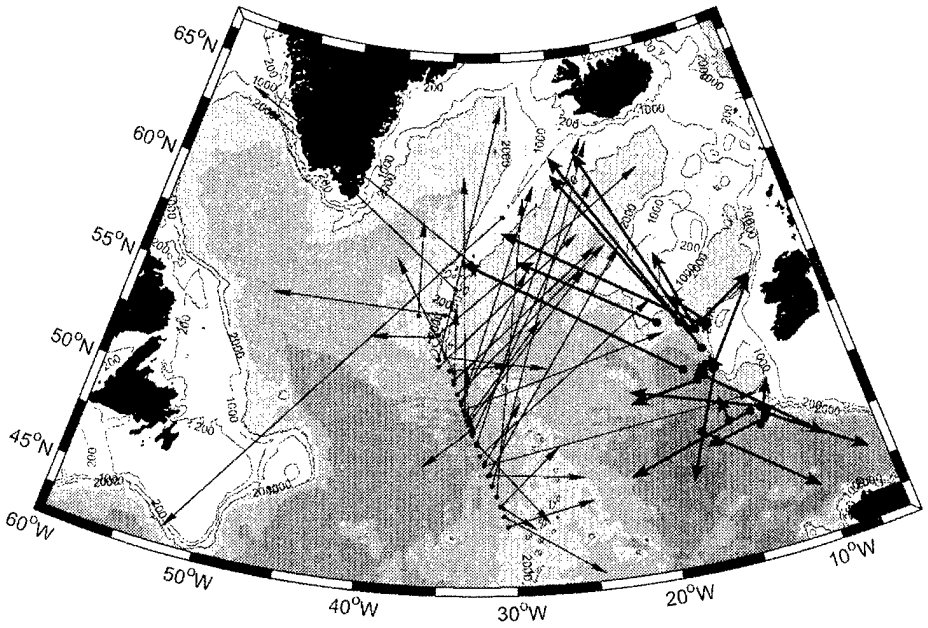
Warm Water Pathways in the Northeastern North Atlantic ACCE RAFOS Float Data Report November 1996 - November 1999

by

Heather H. Furey, Amy S. Bower, and Philip L. Richardson
Woods Hole Oceaographic Institution, Woods Hole, MA 02543

November 2001



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Technical Report

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Terrence M. Joyce

Terrence M. Joyce, Chair

Department of Physical Oceanography

Abstract

This is the final data report of all acoustically tracked RAFOS float data collected by the Woods Hole Oceanographic Institution in 1996-1997 during the Atlantic Circulation and Climate Experiment (ACCE). The RAFOS float component of ACCE, entitled "Warm Water Pathways and Intergyre Exchange in the Northeastern North Atlantic", was designed to measure the warm water currents entering the northeastern North Atlantic which become the source of intermediate and deep waters in the subpolar region. The experiment was comprised of three RAFOS float deployments on the R/V Knorr: the first in fall 1996 along the continental slope seaward of Porcupine Bank, the second in spring 1997 along the mid-Atlantic Ridge, and the final deployment in fall 1997 along both the Ridge and the Bank. Seventy floats were deployed, 13 RAFOS and 2 ALFOS in fall 1996, 14 RAFOS in spring 1997, and 41 RAFOS in fall 1997. The isobaric ALFOS floats were ballasted for 800 decibars and were launched to monitor the regions' sound sources during the experiment. The RAFOS floats were isopycnal and ballasted for the 27.5 σ_t surface to target the intermediate-depth North Atlantic and Poleward Eastern Boundary Currents. The objectives of the Lagrangian float study were (1) to provide a quantitative description of the bifurcation of the North Atlantic Current east of the Mid-Atlantic Ridge, (2) to assess the importance of meridional eddy fluxes, compared to large-scale advection, in the northward flux of heat and salt in the northeastern North Atlantic, and (3) to establish the degree of continuity of the Poleward Eastern Boundary Current as it flows to the entrance of the Norwegian Sea and the fate of the Mediterranean Outflow Water carried by this current.

Front Cover Figure Caption: Vector displacement diagram for the WHOI RAFOS floats deployed for the ACCE experiment. The floats launched along the eastern boundary of the Atlantic have a heavier line weight than those launched over the mid-Atlantic ridge. Launch position are marked by a dot; surface positions are at the arrowheads. The 200-, 1000-, and 2000-meter isobaths are labeled; bathymetry is shaded in 1000-meter intervals.

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1. Introduction

This is the final data report of all acoustically tracked Ranging and Fixing of Sound (RAFOS) float data collected during the 1996-1999 "Warm Water Pathways and Intergyre Exchange in the northeastern North Atlantic" (hereafter referred to as "WWP") component of the Atlantic Climate Change Experiment (ACCE) Subpolar Experiment. ACCE was designed as a broad scale program to investigate the ocean circulation's affect on climate variability. The program focused on the Atlantic's subpolar meridional overturning circulation (MOC) and the effects of the MOC on atmospheric climate.

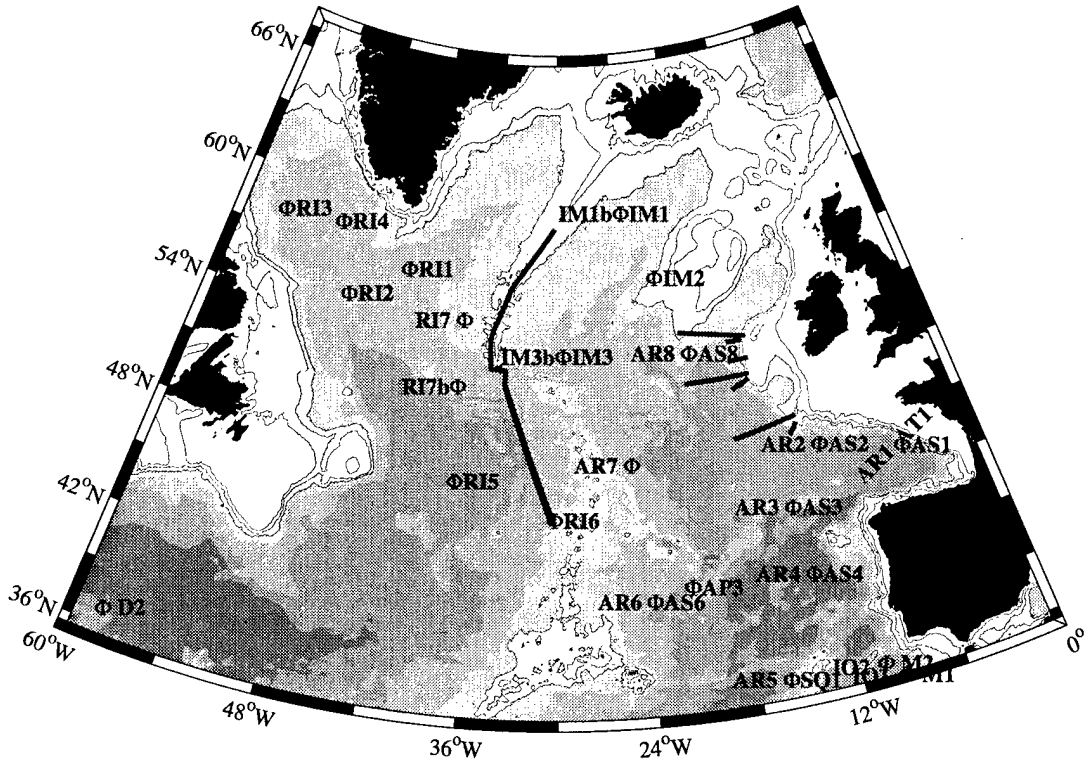

Figure 1: Chart depicting the cruise track segments on which the RAFOS floats were launched (solid black lines). Cruise KN147 ran the longer segments perpendicular to the Porcupine Bank; cruise KN151 followed along the mid-Atlantic Ridge, cruise KN154 was in both regions, with the shorter segments perpendicular to the Porcupine Bank. Sound sources available to the ACCE experiment are marked with the symbol Φ and the source code. Sources are identified as follows: RI* - University of Rhode Island (URI), SQ* and IM* - Institut für Meereskunde Kiel (IfMK), AR*, AS*, AP* - sound sources of the Service Hydrographique et Océanographique de la Marine (SHOM), D*, M* - sound sources of the Woods Hole Oceanographic Institution (WHOI), IO* = sound sources of the Instituto de Oceanografia, Universidade de Lisboa (IOUL). Additional sound sources are located outside the region mapped in this figure. The 200-, 1000-, and 2000-meter isobaths are labeled; bathymetry is shaded in 1000-meter intervals.

The WWP program used subsurface isopycnal drifters to measure pathways of the subpolar gyre. The objectives of this experiment are: (1) to provide a quantitative description of the bifurcation of the North Atlantic Current (NAC) east of the mid-Atlantic Ridge; (2) to assess the importance of the meridional eddy fluxes, compared to large-scale advection, in the northward flux of heat and salt in the northeastern North Atlantic; and (3) to establish the degree of continuity of the

Poleward Eastern Boundary Current (PEBC) to the entrance of the Norwegian Sea and the fate of the Mediterranean Outflow Water carried by this current.

Sixty-eight isopycnal RAFOS floats were ballasted for the σ_t =27.5 density surface which extends from about 100 meters depth in the northwestern subpolar gyre to 800 meters depth near the eastern boundary (see Figure 2). The floats were deployed from the R/V Knorr on three cruises: in November-December 1996 (KN147), May-June 1997 (KN151), and October-November 1997 (KN154). In addition, two ALFOS floats were deployed on the first cruise to monitor the sounds sources used for tracking the RAFOS floats. The majority of RAFOS and ALFOS float missions were two years in length. The floats were tracked using numerous sound sources that had been moored by different institutions for ACCE and other experiments, as shown in Figure 1. WHOI provided one source that was also used in this program.

The WWP was highly coordinated with other ACCE subpolar field experiments, as well as with a number of simultaneous European float programs (see the WOCE web page for an overview, http://www.soc.soton.ac.uk/OTHERS/woceipo/ipo.html). Of particular note here are "A Study of the Extension of the North Atlantic Current and Pathways Exchange" conducted by the University of Rhode Island also as part of ACCE (http://mail.po.gso.uri.edu/rafos/research/acce/index.html), the French ARCANE program (http:/www.ifremer.fr/lpo/arcane/), and European Union EUROFLOAT program (http:/www.ifremer.fr/lpo/eurofloat/). All of these studies are aimed at understanding the mid-depth circulation of the northeastern North Atlantic using acoustically-tracked subsurface floats.

2. Description of the RAFOS and ALFOS Floats

The RAFOS float is an acoustically tracked subsurface Lagrangian drifter (see Rossby *et al.*, 1986, for a complete description of the RAFOS system), which is programmed to listen for signals from moored sound sources. The RAFOS floats record the time-of-arrival (TOA) of these signals, from which, given the speed of sound in seawater, position can be determined. The TOA of the acoustic signals, as well as temperature and pressure measurements, are recorded in the float's micro-processor memory. Also stored in the float's memory are correlation heights for each TOA, which indicate the quality of the TOA signal heard. The sound sources in this experiment were programmed to transmit an 80-second-long continuous wave tone, which linearly increases its frequency from 259.375 Hz to 260.898 Hz. The individual sound sources broadcast this tone twice a day, and broadcast at different times (beginning at 0030, 0100, 0130 and 0200 UTC, and then twelve hours later). The floats in this experiment recorded these signals once a day, beginning at 0000 UTC. The float temperature sensors were built by Yellow Springs Instrument Company and were calibrated to ±0.01°C. Float pressure sensors were built by Data Instruments and calibrated to ±1% at 2000 psi.

The isopycnal floats were used to seed the NAC and the PEBC, as described in the Introduction. The WHOI Float Operations Group (Jim Valdes, Bob Tavares, and Brian Guest) ballasted the floats in the WHOI ballasting tanks. Isobaric floats were ballasted with a solid drop weight that forces the floats to be neutrally buoyant at a desired pressure surface. (More details on the ballasting procedure can be found in Anderson-Fontana et al. (1996).) Isopycnal floats are identical to isobaric floats, but with the addition of a "compressee" attached with the weight package, outside the float body. The compressee is designed so that the entire float package has nearly the same compressibility as seawater (Rossby *et al.*, 1985), thus allowing the float to follow water parcels along density surfaces more closely. The isopycnal floats were seeded to

follow the σ_t = 27.5 density surface, which is less than 100 dbar deep in the Labrador and Irminger Basins (even outcropping there in winter), deepens sharply across the North Atlantic Current, and is deeper than 800 dbar near the eastern boundary (Figure 2).

After the float completes its mission (in this application, usually after two years), it drops its external ballast, rises to the ocean surface, and telemeters its data to ARGOS receivers aboard the NOAA Polar Orbiting Environmental Satellites. Through ARGOS, the data are relayed to a

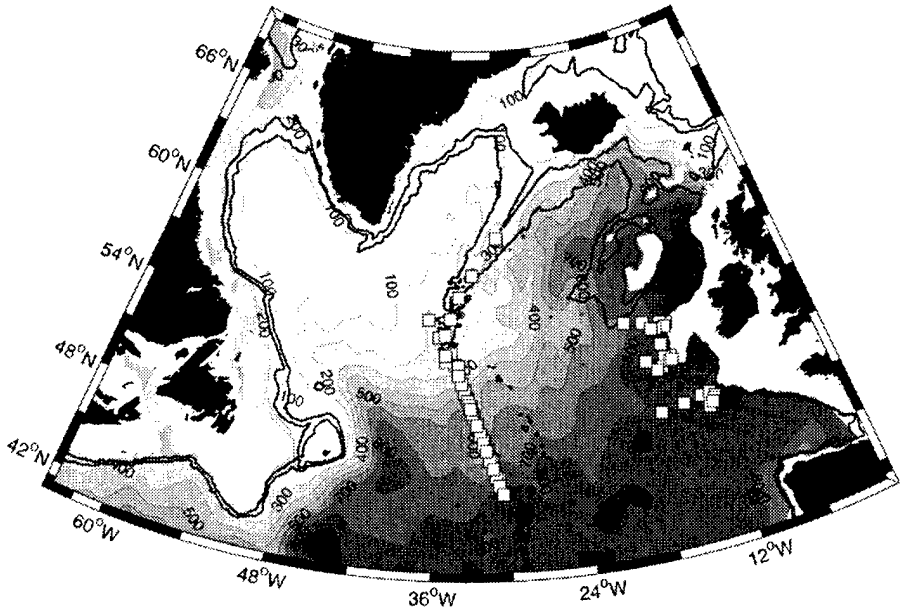

Figure 2. Pressure on the density surface σ_t = 27.5, the density for which the RAFOS floats were ballasted. White boxes depict launch locations of the floats on the three cruises. The 1000 and 2000 meter isobaths are drawn with bold line weight.

ground station and transferred to a Global Processing Center. At the Global Processing Center, the data are processed and then transferred via the Internet to WHOI. The float data, including temperature, pressure, TOAs and respective correlation heights, are converted from hexadecimal to decimal, and are then ready for editing and tracking.

The ALFOS float is a combination of an ALACE (Autonomous Lagrangian Circulation Explorer) float and RAFOS float. An ALACE float (Davis, et al., 1991) drifts at constant pressure, repeatedly comes to the sea surface to fix its position and transmit its data in a manner similar to the RAFOS float. An ALACE does not use sound sources to record sub-surface position, rather it drifts for a set period of time, surfaces, transmits its position and data, and then re-submerges for another cycle. The ALFOS float records daily TOAs like the RAFOS float, and surfaces to transmit its location and TOAs at a fixed cycle length like the ALACE, in this experiment, every thirty days. (The ALFOS is much like a MARVOR float, described by Ollitrault, et al., 1994.) The ALFOS floats were built by Webb Research, and were used in this experiment to monitor the sound sources. By transmitting the TOAs every thirty days, we were alerted to sound sources that had stopped transmitting.

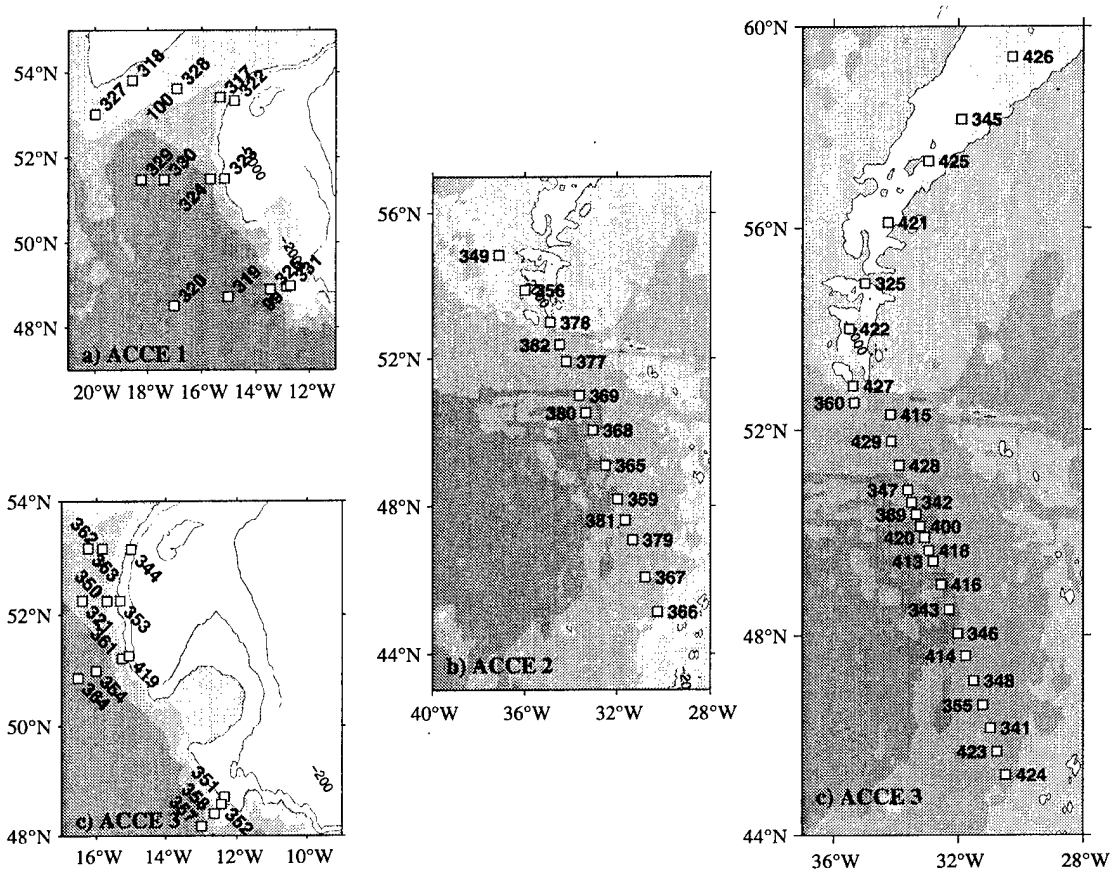

Figure 3. Expanded view of launch locations for the three R/V Knorr cruises. a) ACCE 1 (KN147) in November-December 1996 off the Porcupine Bank. ALFOS deployments were floats 99 and 100. b) ACCE 2 (KN151) in May-June 1997. c) two panel, ACCE 3 (KN154) in October-November 1997. Bathymetry is represented as in Figure 1.

3. Sound Sources

Thirty-seven sound sources used in this experiment were moored in the northeastern Atlantic, by several institutions: University of Rhode Island, Institut für Meereskunde Kiel, Service Hydrographique et Océanographique de la Marine, Woods Hole Oceanographic Institution, Instituto de Oceanografia, and Universidade de Lisboa (Figure 1). The comprehensive list of the sound sources, their locations, and other vital statistics can be found at the Eurofloat Project's homepage, http://www.ifremer.fr/lpo/eurofloat/, maintained by Thierry Reynaud of Ifremer.

Particularly useful to this experiment were the new sources designed by Sparton (electronics provided by Webb Research) that broadcasted about 10-15 db louder than the standard source (Figure 1: RI5, RI6, RI7 and RI7b). The 'loud' sound sources were moored by T. Rossby for a companion experiment under the ACCE Subpolar Experiment. They were clearly heard above all other sources, even when other sound sources were closer to the floats, and were especially valuable for tracking. Sound source drifts were calculated for several sources, as detailed in Section 6.

Table 1. Float Summary

Float ID	LAUNCH Date	Time (GMT)	Latitude	Longitude	SURFACE Date	Time (GMT)	ARGOS Fix-time (GMT)	Latitude	Longitude	Status Code[1]
ACCE 1: KN147										
w317	961126	0113	53.417 °N	15.328°W	981126	0300	0834	55.004°N	10.586°W	00
w318	961126	2332	53.816°N	18.570°W	981126	0300	0642	57.318°N	29.220°W	00
w319	961201	2328	48.723 °N	15.017°W	981201	0300	1720	49.954°N	15.381°W	00
w320	961201	1055	48.510°N	17.008°W	981201	0300	0827	44.683°N	10.308°W	00
w322	961125	1611	53.335°N	14.797°W	981125	0300	0511	54.906°N	17.335°W	00
w323	961130	0737	51.508°N	15.155°W	970228	0300	N/A	N/A	N/A	SM/66
w324	961129	1424	51.492°N	15.680°W	970227	0300	0440	50.951°N	16.768°W	SM/0
w326	961202	1308	48.898°N	13.463°W	981202	0300	0714	46.999°N	22.115°W	00
w327	961127	1606	53.016°N	19.984°W	no show					
w328	961126	1349	53.617°N	16.908°W	981126	0300	0640	61.183°N	25.756°W	00
w329	961128	2200	51.480°N	18.246°W	980607	0300	0456	N/A	N/A	66
w330	961129	0331	51.481°N	17.382°W	981129	0300	0820	57.287 °N	33.640°W	00
w331	961203	0248	48.978°N	12.712°W	981203	0300	0344	50.868°N	21.432°W	00
a099[2]	961203	0022	48.965°N	12.865°W	000927	0300	0620	44.273°N	12.270°W	00
a100[2]	961126	1344	53.616°N	16.905°W	990312	0300	0656	65.210 °N	33.429°W	00
ACCE 2: KN151										
w349	970621	1120	54.839°N	37.131°W	990621	0300	0638	59.186°N	37.157°W	00
w356	970622	0446	53.881°N	36.000°W	990622	0300	0629	53.741°N	40.662°W	00
w359	970624	2129	48.181°N	31.968°W	990624	0300	0745	50.947°N	29.348°W	00
w365	970624	1203	49.093°N	32.500°W	990624	0300	0605	45.290°N	27.803°W	00
w366	970625	2137	45.148°N	30.266°W	no show					
w367	970625	1818	46.085°N	30.788°W	990625	0300	0921	45.038°N	28.671°W	00
w368	970623	2242	50.038°N	33.042°W	990623	0300	0615	56.780 °N	23.599°W	00
w369	970623	1442	50.980°N	33.634°W	990623	0300	0755	56.838°N	28.434°W	00
w377	970623	0546	51.918°N	34.211°W	990623	0300	0615	57.694°N	22.514°W	00
w378	970622	1055	52.995°N	34.904°W	990622	0300	0628	52.375 °N	27.319°W	00
w379	970625	0851	47.084°N	31.326°W	970626	0300	0446	47.029°N	31.315°W	80
w380	970623	2200	50.515°N	33.354°W	970822	0300	0422	49.499°N	32.564°W	SM/0
w381	970625	0319	47.616°N	31.632°W	990625	0300	0734	47.291°N	25.283°W	00
w382	970623	0106	52.379°N	34.496°W	970821	0300	0616	52.643°N	29.968°W	SM/0
ACCE 3: KN154										
w321	971104	0257	52.251°N	16.407°W	no show					
w325	971021	2119	54.902°N	34.996°W	990810	0300	0716	54.994°N	48.767°W	66?
w341	971017	1520	46.154°N	30.967°W	991017	0300	0615	48.785°N	26.871°W	00?
w342	971019	0924	50.595°N	33.489°W	991019	0300	0407	53.325°N	18.240°W	00

w343	971018	1412	48.512°N	32.285°W	991018	0300	0600	54.915°N	18.756°W	00
w344	971103	0026	53.157°N	14.999°W	991102	0300	0450	58.661°N	30.413°W	00
w345	971023	0128	58.150°N	31.900°W	no show					
w346	971018	0922	48.037°N	32.012°W	991018	0300	0421	49.627°N	12.739°W	00
w347	971019	1203	50.832°N	33.611°W	991019	0300	0548	60.785°N	27.380°W	00
w348	971018	0058	47.097°N	31.501°W	991017	0300	0609	62.555°N	22.046°W	00
w350	971103	2314	52.245°N	15.703°W	991103	0300	0617	62.014°N	25.806°W	00
w351	971106	0330	48.715°N	12.347°W	980414	0300	0906	48.820°N	11.730°W	80
w352	971106	0531	48.585°N	12.434°W	991105	0300	0418	45.672°N	6.568°W	00
w353	971103	2009	52.252°N	15.318°W	no show					
w354	971104	1515	50.998°N	16.014°W	991104	0300	2018	46.894°N	9.019°W	00
w355	971017	2036	46.615°N	31.202°W	991017	0300	0749	60.193°N	28.391°W	00
w357	971106	1223	48.175°N	12.987°W	991105	0300	1011	50.184°N	11.715°W	00?
w358	971106	0831	48.404°N	12.632°W	991105	0300	0705	47.787°N	16.894°W	00
w360	971020	1603	52.538°N	35.338°W	991019	0300	0728	58.392°N	23.913°W	00
w361	971104	2201	51.222°N	15.258°W	991104	0300	0609	54.826°N	10.737°W	00
w362	971103	0556	53.167°N	15.834°W	991102	0300	1116	57.004°N	17.829°W	00
w363	971103	0837	53.174°N	16.245°W	991102	0300	0950	62.078°N	23.396°W	00
w364	971104	1109	50.865°N	16.525°W	991104	0300	1034	50.296°N	21.474°W	00
w389	971019	0758	50.364°N	33.344°W	991018	0300	0558	61.235°N	33.690°W	00
w400	971019	0421	50.129°N	33.217°W	991018	0300	0600	54.647°N	27.527°W	00
w413	971018	2222	49.453°N	32.805°W	991018	0300	0704	60.667°N	21.995°W	00
w414	971018	0550	47.594°N	31.752°W	991018	0300	0830	57.549°N	20.564°W	00
w415	971020	0505	52.304°N	34.170°W	991019	0300	0731	57.390°N	39.197°W	00
w416	971018	1847	48.998°N	32.545°W	991018	0300	0557	62.750°N	22.499°W	00
w418	971018	2336	49.660°N	32.939°W	990616	0300	0556	47.939 °N	36.222°W	66
w419	971105	0000	51.266°N	15.061°W	991104	0300	1033	46.347°N	18.179°W	00?
w420	971019	0306	49.913°N	33.078°W	991018	0300	0741	52.544°N	33.255°W	00
w421	971022	0715	56.110°N	34.249°W	991021	0300	0847	63.016°N	53.656°W	00
w422	971021	1328	54.001°N	35.502°W	991018	0300	0846	60.979°N	17.608°W	00
w423	971017	1118	45.687°N	30.747°W	991017	0241	0613	42.752°N	24.555°W	00
w424	971017	0548	45.216°N	30.473°W	991016	0300	0624	46.200°N	24.811°W	00?
w425	971022	1741	57.326°N	32.958°W	991022	0300	1016	63.771°N	55.439°W	00
w426	971023	1235	59.389°N	30.262°W	991023	0300	0649	43.242°N	52.165°W	00
w427	971021	0507	52.867°N	35.384°W	991020	0300	0536	64.467°N	30.141°W	00
w428	971019	1658	51.309°N	33.888°W	991019	0300	0642	57.755°N	21.639°W	00
w429	971019	2136	51.781°N	34.144°W	991019	0300	0549	55.248°N	34.145°W	00

1. Status codes at end of float mission. 0, 00: normal mission, 66: low battery, 80: over pressure, 83: lost weight, SM: purposefully short mission. If '?', then first message not received, and status code is assumed.
2. a099 and a100 are ALFOS floats.

4. Float Deployment

Seventy floats were deployed on three cruises. The first cruise was in November-December 1996 on the R/V Knorr, from which 13 RAFOS and 2 ALFOS floats were deployed off the Porcupine Bank (Figure 3a). The next cruise was in May-June of 1997 on the R/V Knorr, from which 14 RAFOS floats were deployed over the mid-Atlantic Ridge (Figure 3b). Finally, on the October-November 1997 R/V Knorr cruise, 27 floats were launched along the ridge, and 14 along the boundary (Figure 3c, two panels). All floats were ballasted for the $\sigma_t = 27.5$ surface (see Figure 2).

A summary of the float launch and surface times and locations is found in Table 1. The strategy for choosing the launch sites in the WWP experiment was generally as follows: Floats launched over the mid-Atlantic Ridge targeted the NAC, with some floats launched to the south and north of the NAC, and a higher density of floats deployed in the central region as determined by real-time shipboard hydrography. Floats launched in sections perpendicular to the eastern boundary, offshore of the Porcupine Bank, were deployed to seed the northward flowing PEBC. The multiple sections off the eastern boundary were designed to observe any divergence of flow of the PEBC, and to find the northern extent of this current. Two deployments in each region gave two realizations of each current. All float launching used the float launch tube built by Brian Guest.

5. Float Performance

Sixty-four of the 68 RAFOS and 2 ALFOS floats were deployed for 730-day missions. The remaining 4 RAFOS floats were deployed as tests with shorter mission lengths: two on the first cruise for 90-day missions, and two on the second cruise for 60-day missions. The two ALFOS floats completed their missions successfully. Out of the 68 RAFOS floats deployed, 57 surfaced on time (54 after two years, one after 90 days, and two after 60 days). One of these had a pressure sensor malfunction, and no pressure data were recorded. Of the remaining 11 RAFOS floats, 4 surfaced early due to low battery, 2 surfaced early due to over-pressure, and 5 failed to transmit at all ("no-shows"). Summaries of the float missions are described in Table 1. The duration chart in Figure 4 describes visually the RAFOS float missions in time (no-shows not plotted). In total, 89% of the total RAFOS float mission was accomplished.

In general, ballasting of the floats was good. Table 2 shows the ballasting performance for each float. For the three deployments, the target density was $\sigma_t = 27.5$. The average σ_t at the depth of the float on the first record after launch (obtained from CTD data) was 27.564, or 0.064 sigma units too heavy. This corresponds to a deviation in depth of less than 100 meters. The ballasting on the first and last cruises was much better (0.009 and 0.037 sigma units too heavy, respectively) than the second cruise (0.147 sigma units too heavy). This was due to the fact that the same temperature and pressure ballasting targets were used in the ballasting computation for ACCE 1 (along the Porcupine Bank where the same density surface lies at about 900 meters depth) as for ACCE 2 (floats were launched along the MAR where the target density surface lies at about 500 meters depth, see Figure 2), and the fact that the floats did not have the exact same compressibility as seawater. Because the float compressibilities were somewhat less than seawater, it was important to use the actual pressure of the 27.5 surface at the location where the floats were launched. In ACCE 1, the actual pressure was around 900 dbars where the floats

were launched, which is the same as the target used. Hence the ballasting was very successful. In ACCE 2 the pressure of the 27.5 surface was more like 500-600 m, but 900 was used as the target. This led to slightly more weight being added (< 2 g), and the floats ending up a little too dense. In ACCE 3, two different target pressures were used (Table 2) for the two locations.

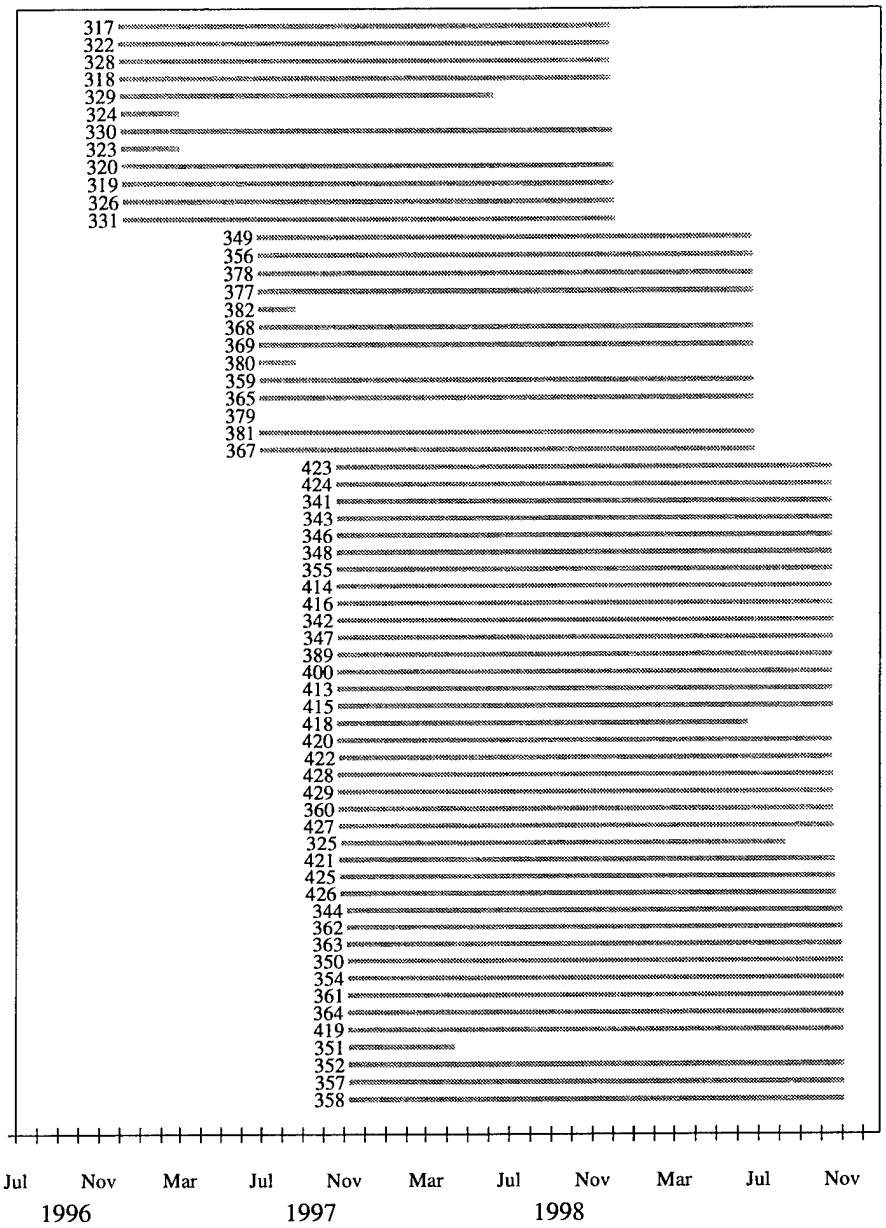

Figure 4. RAFOS float duration chart showing length of each float mission. Floats that failed to transmit (no-shows) are not plotted.

Table 2. RAFOS Float Ballasting/Temperature Performance

Float ID	*CTD stations*	*Float Initial Temp (C)*	*Float Initial Pres (dbars)*	*Float target density/ pressure*	*CTD sigma-t*	*Δ Density (float-CTD) (kg/m³)*	*# records: temp/pres*[1]
ACCE 1: KN147							
w317	141	8.35	848	27.500/900	27.467	-0.033	1/1
w318	146	6.35	678	27.500/900	27.578	0.078	0/0
w319	173	8.82	886	27.500/900	27.474	-0.026	1/1
w320	171	8.40	885	27.500/900	27.528	0.028	0/0
w322	137	8.89	875	27.500/900	27.438	-0.062	0/0
w323	166	9.14	894	27.500/900	27.493	-0.007	9/9
w324	159	8.88	880	27.500/900	27.504	0.004	0/0
w326	176	9.68	872	27.500/900	27.513	0.013	0/0
w327	150			27.500/900	no show		
w328	144	7.13	803	27.500/900	27.556	0.056	0/0
w329	156	7.15	828	27.500/900	27.517	0.017	44/44
w330	157	7.82	755	27.500/900	27.522	0.022	0/3
w331	181	9.58	898	27.500/900	27.517	0.017	1/1
						Mean = 0.009	
ACCE 2: KN151							
w349	113	4.86	586	27.500/900	27.644	0.144	0/0
w356	115	4.51	652	27.500/900	27.688	0.188	0/0
w359	129	5.60	635	27.500/900	27.572	0.072	0/0
w365	127	5.54	718	27.500/900	27.575	0.075	0/0
w366	135			27.500/900	no show		
w367	133	6.06	718	27.500/900	27.607	0.107	0/0
w368	125	4.86	651	27.500/900	27.619	0.119	1/1
w369	123	4.41	619	27.500/900	27.683	0.183	0/0
w377	121	4.07	653	27.500/900	27.711	0.211	1/1
w378	117	4.69	613	27.500/900	27.684	0.184	1/1
w379[2]	131	3.47	1646	27.500/900	--	--	1/1
w380	124	4.65	568	27.500/900	27.663	0.163	0/0
w381	130	4.89	684	27.500/900	27.641	0.141	1/1
w382	120	4.46	591	27.500/900	27. 671	0. 171	1/1
						Mean = 0.147	
ACCE 3: KN154							
w321	120			27.500/900	no show		
w325	41	5.18	594	27.500/500	27.646	0.146	4/4
w341	16	6.30	874	27.500/500	27.558	0.058	1/1
w342	25-26	5.95	624	27.500/500	27.547	0.057	0/0
w343	21	5.86	617	27.500/500	27.583	0.083	0/0

w344	112	8.06	900	27.500/900	27.279	-0.221	1/1
w345	49			27.500/500	no show		
w346	20	5.71	620	27.500/500	27.535	0.035	0/0
w347	26	6.37	503	27.500/500	27.449	-0.051	0/0
w348	18	6.85	682	27.500/500	27.468	-0.032	1/1
w350	119	8.35	897	27.500/900	27.444	-0.056	0/0
w351	131	8.87	1121	27.500/900	27.648	0.148	1/0
w352	132	9.48	927	27.500/900	27.546	0.046	1/1
w353	118			27.500/900	no show		
w354	122	7.84	945	27.500/900	27.509	0.009	0/0
w355	17	7.12	701	27.500/500	27.457	-0.043	1/1
w357	134	8.95	849	27.500/900	27.471	-0.029	1/1
w358	133	9.05	986	27.500/900	27.561	0.061	1/1
w360	33	4.95	433	27.500/500	27.642	0.142	1/1
w361[3]	124	8.82	--	27.500/800	--	--	0/--
w362	114	7.04	949	27.500/800	27.499	-0.001	1/1
w363	115	7.88	883	27.500/900	27.465	-0.035	1/1
w364	121	8.79	948	27.500/900	27.512	0.012	0/0
w389	25	5.95	609	27.500/500	27.493	-0.007	1/1
w400	24-25	5.70	608	27.500/500	27.539	0.039	1/1
w413	23	6.05	594	27.500/500	27.583	0.083	0/0
w414	19	6.29	726	27.500/500	27.556	0.056	0/0
w415	30	4.86	389	27.500/500	27.613	0.113	1/1
w416	22	6.10	604	27.500/500	27.570	0.070	0/0
w418	23-24	6.15	600	27.500/500	27.585	0.085	1/1
w419	125	8.97	958	27.500/900	27.517	0.017	1/1
w420	24	5.49	624	27.500/500	27.597	0.097	1/1
w421	44	5.25	599	27.500/500	27.608	0.108	1/1
w422	39	5.39	496	27.500/500	27.595	0.095	3/3
w423	15	7.14	833	27.500/500	27.443	-0.057	0/0
w424	14	7.29	845	27.500/500	27.408	-0.092	1/1
w425	47	6.66	486	27.500/500	27.512	0.012	0/0
w426	52	6.61	635	27.500/500	27.549	0.049	0/0
w427	37	5.02	459	27.500/500	27.631	0.131	1/1
w428	27	5.22	503	27.500/500	27.596	0.096	1/1
w429	28	4.69	439	27.500/500	27.629	0.129	0/0
						Mean = 0.037	

1. Number of records before first temperature/pressure record.
2. Float w379 surfaced after one day because of overpressure.
3. Float w361 returned no pressure data, therefore density calculation not possible.

Table 3. RAFOS Float Clock and ARGOS Information

Float ID	*Reset Date (yymmdd)*	*Initial Float Clock Offset (sec)*	*Surface Due Date (yymmdd)*	*Actual Surface Date (yymmdd)*	*Final Float Clock Offset (sec)*	*Last Date Heard by ARGOS (yymmdd)*	*Days on Surface*	*Msgs Received*[2]		*Status Code*[1]
								#/#	%	
ACCE 1										
w317	961126	0	981126	981126	-42.4	981226	31	434/463	94%	00
w318	961126	-1	981126	981126	-14.5	981230	35	413/463	89%	00
w319	961201	0	981201	981201	-33.3	981211	11	182/463	39%	00
w320	961201	2	981201	981201	-7.5	990129	29	448/463	97%	00
w322	961125	1	981125	981125	-9.5	990206	74	457/463	99%	00
w323	961130	1	970228	970228	4.0	970228	1	2/58	3%	SM/66
w324	961129	0	970227	970227	3.3	970308	10	44/58	76%	SM/0
w326	961202	2	981202	981202	-1.4	990102	32	363/463	78%	00
w327	961127	2	981127	no show						
w328	961126	0	981126	981126	-27.2	981210	15	339/463	73%	00
w329	961128	0	981126	980607	21.8	980607	1	7/353	2%	66
w330	961129	2	981129	981129	-13.7	981207	9	249/463	54%	00
w331	961203	0	981203	981203	-15.1	981208	6	212/463	46%	00
ACCE 2										
w349	970621	1	990621	990621	-24.9	990801	42	450/463	97%	00
w356	970622	0	990622	990622	-60.7	990807	47	456/463	99%	00
w359	970624	-8	990624	990624	-191.3	990814	52	428/463	92%	00
w365	970624	2	990624	990624	-57.2	990817	55	424/463	92%	00
w366	970625	-2	990625	no show						
w367	970625	1	990625	990625	-53.7	990813	50	448/463	97%	00
w368	970623	0	990623	990623	-50.3	990803	42	397/463	86%	00
w369	970623	0	990623	990623	-64.1	990806	45	442/463	96%	00
w377	970623	-2	990623	990623	-56.8	990730	38	398/463	86%	00
w378	970622	-1	990622	990622	-54.6	990807	47	405/463	88%	00
w379	970625	-3	990625	970626	48.6	970626	1	1/1	100%	80
w380	970623	0	970822	970822	-5.9	970830	9	39/39	100%	SM/0
w381	970625	0	990625	990625	-69.4	990728	34	434/463	94%	00
w382	970622	0	970821	970821	-9.1	970828	8	39/39	100%	SM/0
ACCE 3										
w321	971103	-6	991103	no show						
w325	971021	4	991021	990810	-14.9	990810	1	33/417	8%	66?
w341	971017	0	991017	991017	-102.2	991103	18	370/463	80%	00?
w342	971019	0	991019	991019	-48.3	991103	16	379/463	82%	00
w343	971018	-2	991018	991018	-91.6	991201	45	430/463	93%	00

w344	971102	1	991102	991102	-54.9	991225	54	451/463	97%	00
w345	971022	0	991022	no show						
w346	971018	-2	991018	991018	-77.5	991129	43	313/463	68%	00
w347	971019	-1	991019	991019	-116.7	991211	54	428/463	92%	00
w348	971017	-1	991017	991017	-69.5	991112	27	430/463	93%	00
w350	971103	0	991103	991103	-65.4	991223	51	424/463	92%	00
w351	971105	-1	991105	980414	-9.7	980504	21	83/102	81%	80
w352	971105	-1	991105	991105	-60.2	991214	40	462/463	100%	00
w353	971103	-2	991103	no show						
w354	971104	-3	991104	991104	-552.7	991130	27	288/463	62%	00
w355	971017	0	991017	991017	-59.6	991103	18	417/463	90%	00
w357	971105	-6	991105	991105	-184.8	991206	32	306/463	66%	00?
w358	971105	-8	991105	991105	-175.5	991212	38	368/463	79%	00
w360	971019	-4	991019	991019	-156.9	991103	16	391/463	84%	00
w361	971104	-9	991104	991104	-240.5	991122	19	297/463	64%	00
w362	971102	-7	991102	991102	-187.7	991209	38	388/463	84%	00
w363	971102	4	991102	991102	-170.0	991212	41	414/463	89%	00
w364	971104	-8	991104	991104	-184.1	991211	38	398/463	86%	00
w389	971018	4	991018	991018	65.8	991222	66	463/463	100%	00
w400	971018	1	991018	991018	-70.5	991103	17	434/463	94%	00
w413	971018	2	991018	991018	-73.0	991103	17	429/463	93%	00
w414	971018	1	991018	991018	-68.3	991124	38	371/463	80%	00
w415	971019	3	991019	991019	2.6	991103	16	447/463	97%	00
w416	971018	0	991018	991018	-80.1	991102	16	435/463	94%	00
w418	971018	-5	991018	990616	-35.0	990803	49	370/384	96%	66
w419	971104	0	991104	991104	-85.1	991209	36	334/463	72%	00?
w420	971018	0	991018	991018	-61.1	991201	45	433/463	94%	00
w421	971021	2	991021	991021	-63.0	991205	46	459/463	99%	00
w422	971018	-1	991018	991018	-64.8	991120	34	418/463	90%	00
w423	971017	-32	991017	991017	57.2	991102	17	418/463	90%	00
w424	971016	1	991016	991016	-68.1	991125	41	346/463	75%	00?
w425	971022	1	991022	991022	-52.1	991211	51	462/463	100%	00
w426	971023	-60	991023	991023	-53.4	991215	54	415/463	90%	00
w427	971020	1	991020	991020	-57.9	991201	43	463/463	100%	00
w428	971019	1	991019	991019	-44.9	991102	15	361/463	78%	00
w429	971019	1	991019	991019	-75.1	991125	38	397/463	86%	00

1. Status codes at end of float mission. 0, 00: normal mission, 66: low battery, 80: over pressure, 83: lost weight, SM: purposefully short mission. If '?', then first message not received, and status code is assumed.

2. Number of messages received and percentages based on 'good' checksums only.

Table 3 describes the performance of the RAFOS floats that surfaced and transmitted data via ARGOS, including the number of days on surface, and the initial and final float clock offsets. Although the floats were all programmed to transmit for 300 complete data cycles, 8 floats stopped transmitting less than 10 days after surfacing for unknown reasons, which reduced the percentage of messages received. This problem was especially acute in the floats launched on the first cruise. In total, 62.5% messages were received from ACCE 1, 94.4% for ACCE 2, and 84.7% for ACCE 3. The ACCE 1 floats transmitted for 21 days on average (with one float transmitting for a record 74 days), ACCE 2 floats for 36 days on average, and ACCE 3 floats for 34 days.

6. Sound Source Drift Calculations

Dominant sources used in tracking the floats were the loud Rhode Island sources, RI5, RI6, RI7, and RI7b, and also the Iceland Basin Sources, IM1, IM2, and IM3. Three of these sources (IM2, RI5, RI6) had no directly observed drift estimates because the sources had not been recovered, and their clocks had not been checked, by the time we tracked the floats (fall 2000). We estimated source clock drifts of sources IM1, IM2, IM3, RI5, RI6, and RI7b, using IM1, IM3, and RI7b as controls: in these three cases, the initial and final source clock offsets were known from actual clock checks. In calculating source clock drifts for the six sources, we tried to use all available floats (63), regardless of distance between float and sound source at the time the travel time was recorded, and regardless of time between float surface and the first ARGOS fix. The only criterion was that a TOA existed for the first (last) record after (before) launch (surface). In the end, forty-eight floats were used, with some floats yielding drift estimates both at launch and surface. The float position at surface was extrapolated back to the time of surface from the first two ARGOS positions after surface.

The mean drift values calculated with all available data had large standard deviations. A plot of drift estimates versus the distance between the float and sound source shows no obvious correlation between drift estimate and distance. [One might have expected to see that the farther the float was from the source, differences in the sound velocity field contributed to greater scatter in the drift estimates.] When plotting drift estimates versus the number of days between sound source launch and travel time date (not shown), a source of scatter in drift estimates becomes clear. The greater the number of days over which the drift estimate was calculated, the more stable the drift value becomes.

Based on these results, we decided to eliminate those drifts that were averaged over a period of less than 200 days, and drifts outside a window of +/- 0.08 seconds/day. These cuts removed all drift estimates made from the float launches, and also eliminated the outliers from the drift averages. Our final drift estimates are presented, along with W. Zenk's source clock drifts, T. Rossby's clock check results, and Thierry Reynaud's estimates in Table 4. Where no actual source clock drift was available (IM2, IM3b, RI5, and RI6), we decided to use our clock drift estimates over those provided by Reynaud. We did this because our estimates were based on more float realizations, so may be more statistically accurate, and our estimates worked better for tracking our floats.

Table 4. Sound Source Clock Drift Estimate Table

	IM1 (sec/day)	IM2 (sec/day)	IM3 (sec/day)	RI5 (sec/day)	RI6 (sec/day)	RI7b (sec/day)	Comments
Walter Zenk	**-0.006***	—	**+0.009** (before renewal** 08/10/1998)	—	—	—	W. Zenk's drifts based on actual final clock offsets.
T. Rossby's Source Clock Check	—	—	—	—	—	+0.002 to **+0.003**	Estimate from T. Rossby's cruise where he checked the clock on deck.
WHOI	+0.001	**-0.006**	**-0.003** (after renewal)	**+0.006**	**+0.040**	+0.015	Based on WHOI WWP float data.
Thierry Reynaud, Ifremer	-0.009	-0.009	+0.007 before renewal; -0.007 after renewal	+0.001	+0.036	+0.007	Please note: Sign convention of these results changed to match the URI/WHOI convention, where late yields a positive drift (corrective value).

*** Corrective value sign convention; bold values used in tracking.**
**** Renewal defined as 'source replaced'.**

7. Float Tracking

The floats were tracked using ARTOA software (Boebel, et al. 2000), which originated at the University of Rhode Island, and has been revised and maintained by Olaf Boebel, currently at Alfred Wegener Institute Foundation for Polar and Marine Research in Bremerhaven. ARTOA, which was used to edit the temperature, pressure and TOA data, and to track the floats, is run on MATLAB. The TOAs were corrected for the Doppler shift and difference in transmission time, then interpolated using variable width (usually 20-day) cubic spline filter, before tracking. Tracking used a least-squares method if more than two TOAs were available.

The final sound velocity chosen for this experiment was 1.490 km/sec. Based on the sound velocity field at $\sigma_t = 27.5$ (the float level) and at 1250 dbars (the sound source level), we thought it might be appropriate to have two sound velocity regimes, based on where a float was launched. Sound velocity is slower in the colder western Atlantic, about 1.480 km/sec, and faster in the warmer eastern Atlantic, about 1.495 km/sec, and these values would apply to floats launched over the mid-Atlantic Ridge and along the eastern boundary, respectively. Although the two different sound velocity values helped tracking near the first part of the float's mission in most cases, it did not consistently help at the end of the mission. Additionally, often a float traveled from one sound velocity regime to another within its mission. We decided to use a constant sound velocity of 1.490 km/sec as a compromise.

With so many sound sources available, tracking was usually straightforward, although there were occasions when we could not extract TOA records because there were too many TOAs of different sources intertwined. Significant portions of the TOA records faded out in winter near the northern regions of the Iceland, Irminger and Labrador Basins, when winter mixing degrades

the thermocline. Significant portions of tracks were lost due to the lack of sources in these regions and the Rockall Trough.

Appendix A contains composite displacement vector and track diagrams. Appendix B contains each float's track and property plots, including temperature, pressure, u-velocity, v-velocity, and stick plot showing the direction and magnitude of the float's velocity.

8. Acknowledgements

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Appendix A

The following figures show composite displacement vector diagrams (Figure 1), composite float track diagrams (Figures 2, 3, 4), diagrams showing float track segments of speeds greater than 10 cm/sec and slower than 5 cm/sec (Figure 5), and a float track gallery (Figure 6).

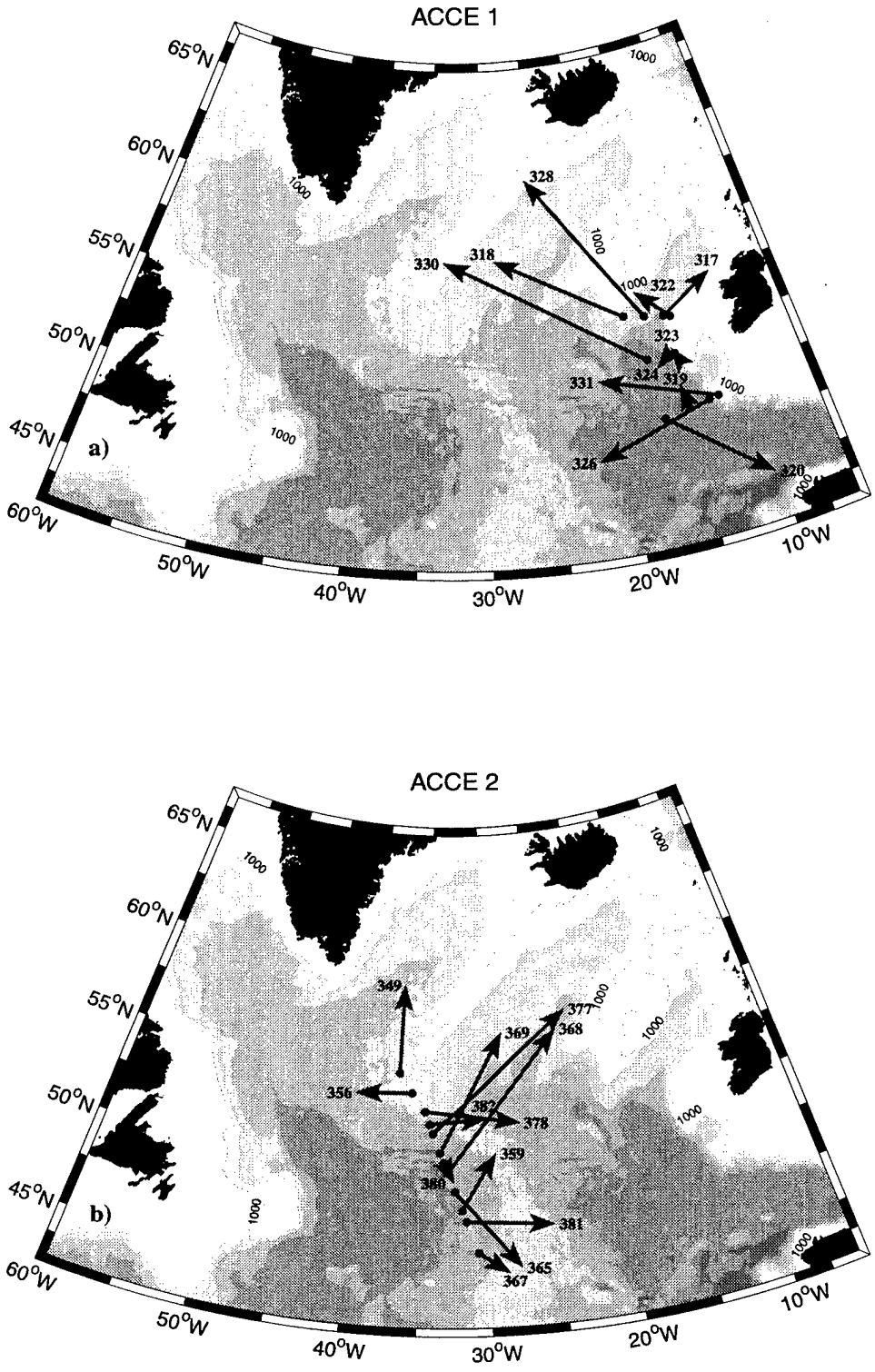


Figure 1. RAFOS float displacement vectors, separated by cruise. Vectors are labeled with float number at the arrowhead. Dots mark the launch positions, and arrowheads the surface positions. The 1000-meter isobath is drawn; bathymetry is shaded in 1000-meter intervals. a) ACCE 1, b) ACCE 2, c) ACCE 3: western deployments, and d) ACCE 3: eastern deployments. Composite vector diagram including all floats is shown in the front cover figure.

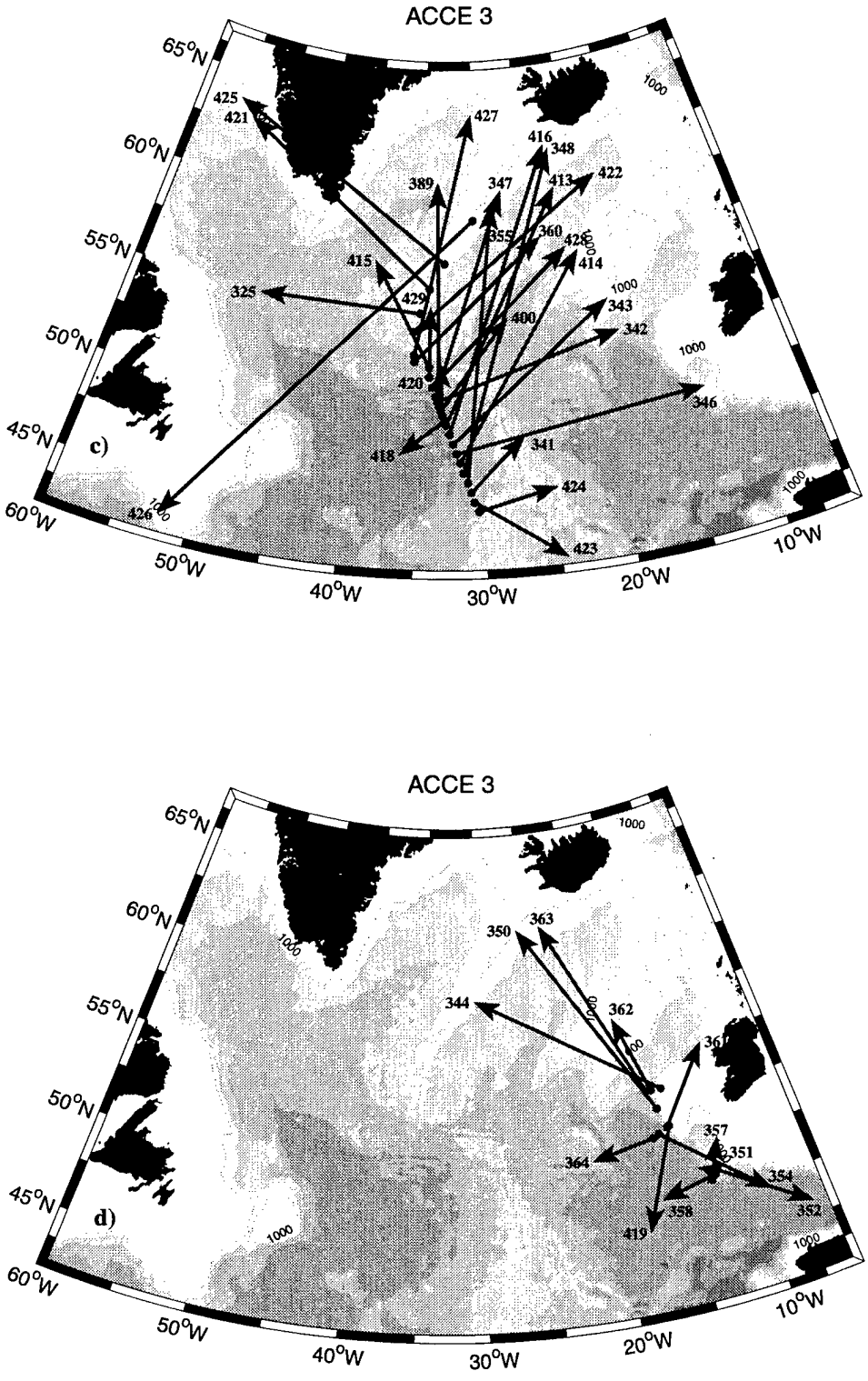


Figure 1 (continued).

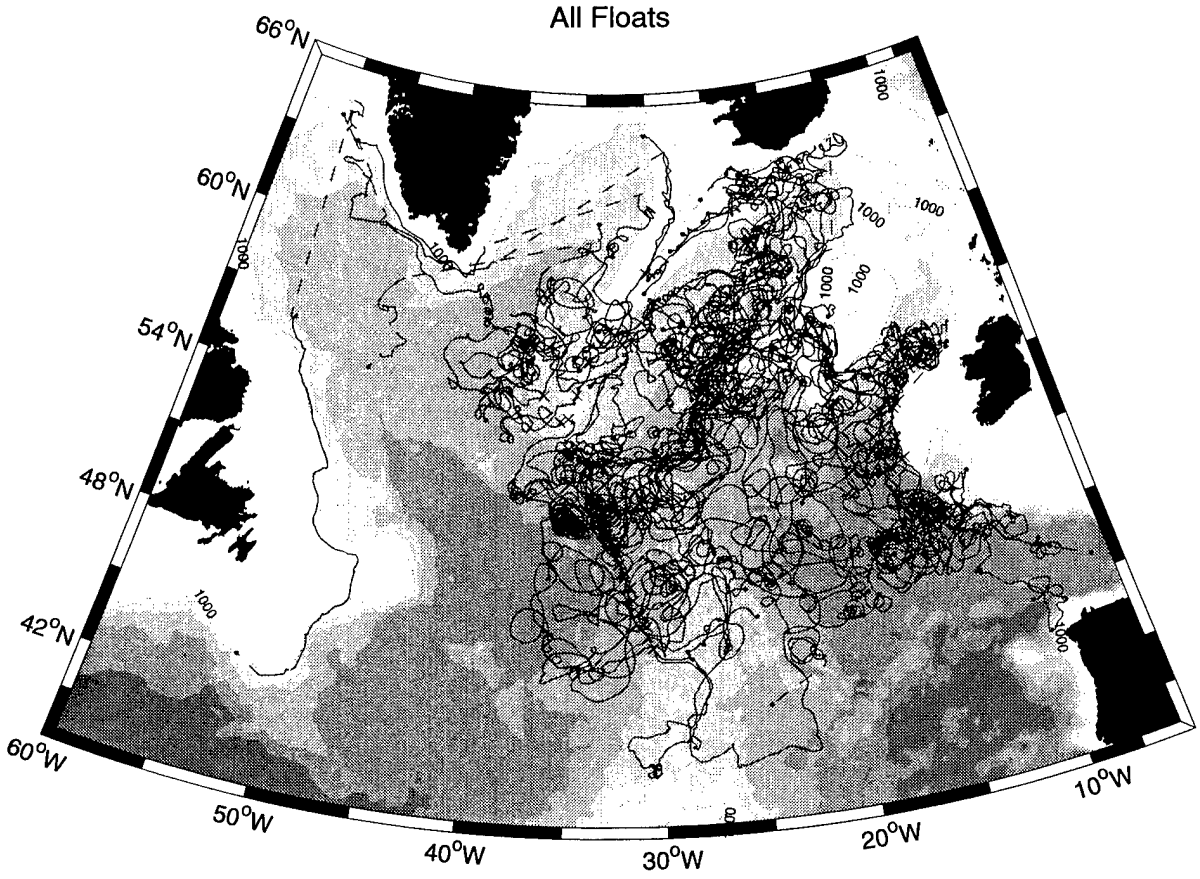


Figure 2. Composite RAFOS float track diagram. All RAFOS float trajectories are shown. Float launch positions are marked with an 'x'; surface positions with a dot. Float tracks are represented as solid black lines, and untrackable segments as dashed lines. Bathymetry is as in Figure 1.

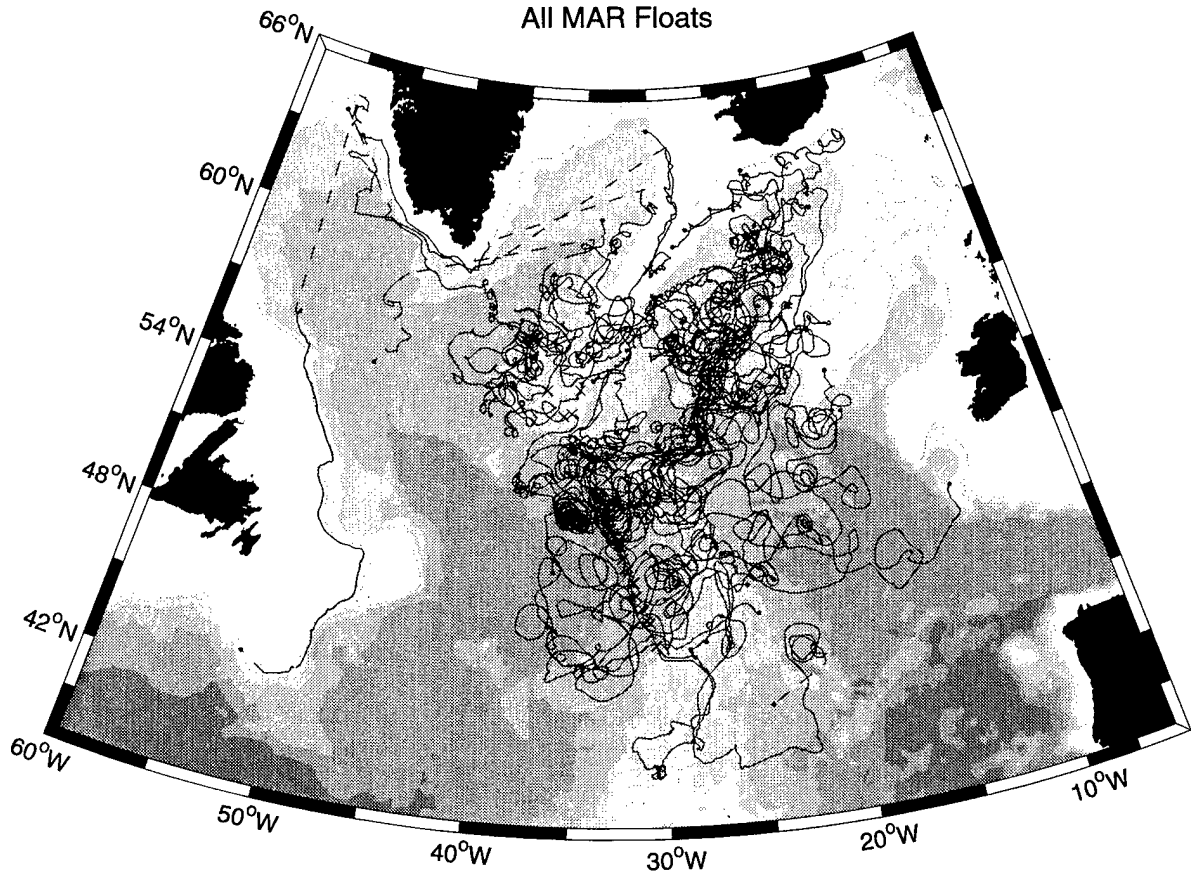
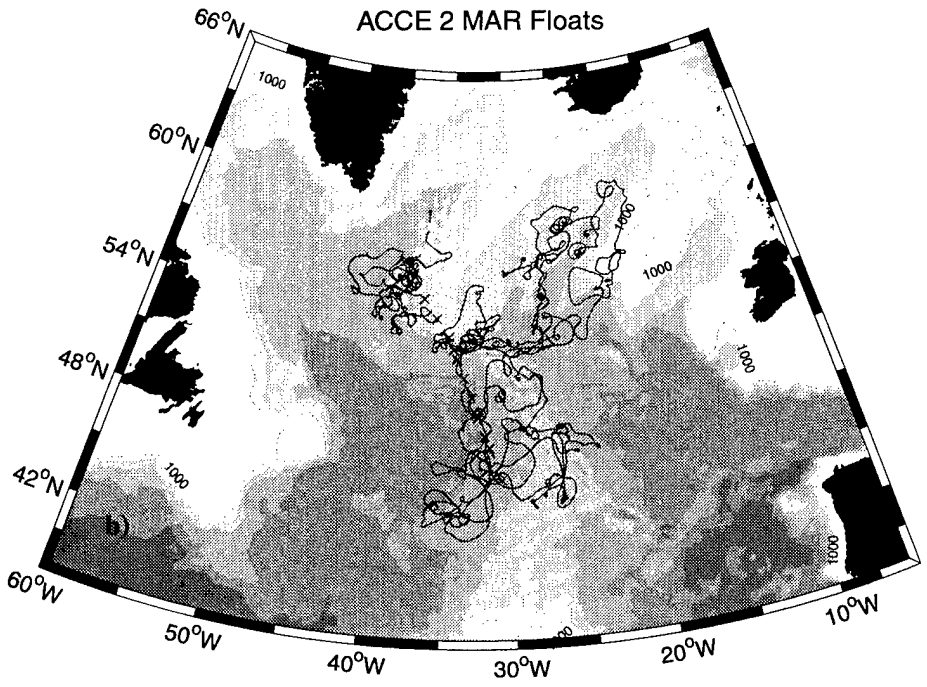


Figure 3. Composite RAFOS float track diagrams for floats launched over the mid-Atlantic ridge, presented as in Figure 2. a) All RAFOS floats launched over the MAR during the WWP experiment.



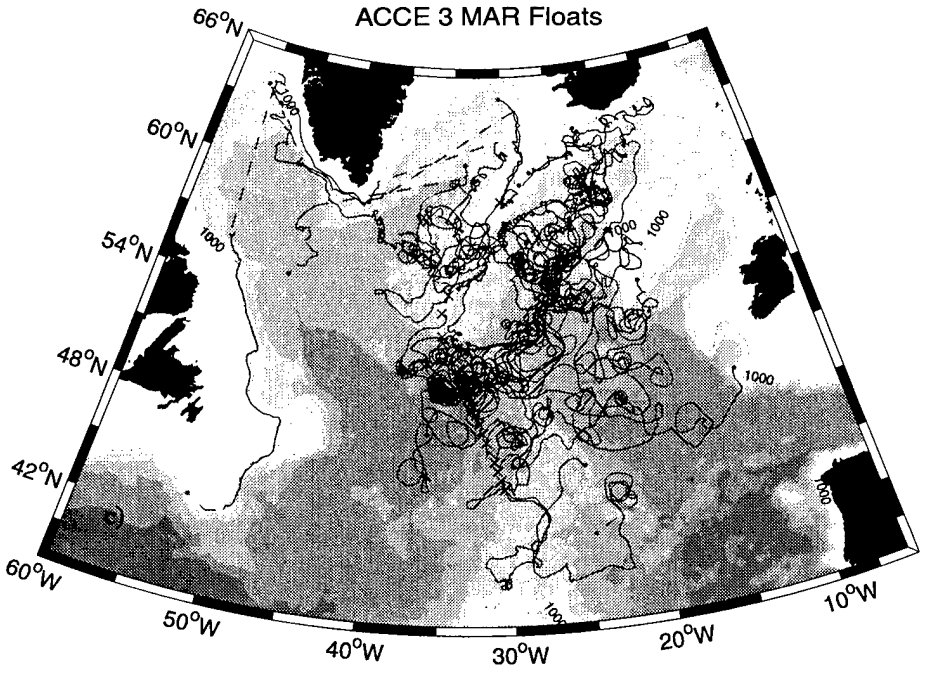


Figure 3, continued. b) MAR floats of ACCE 2, and c) MAR floats of ACCE 3.

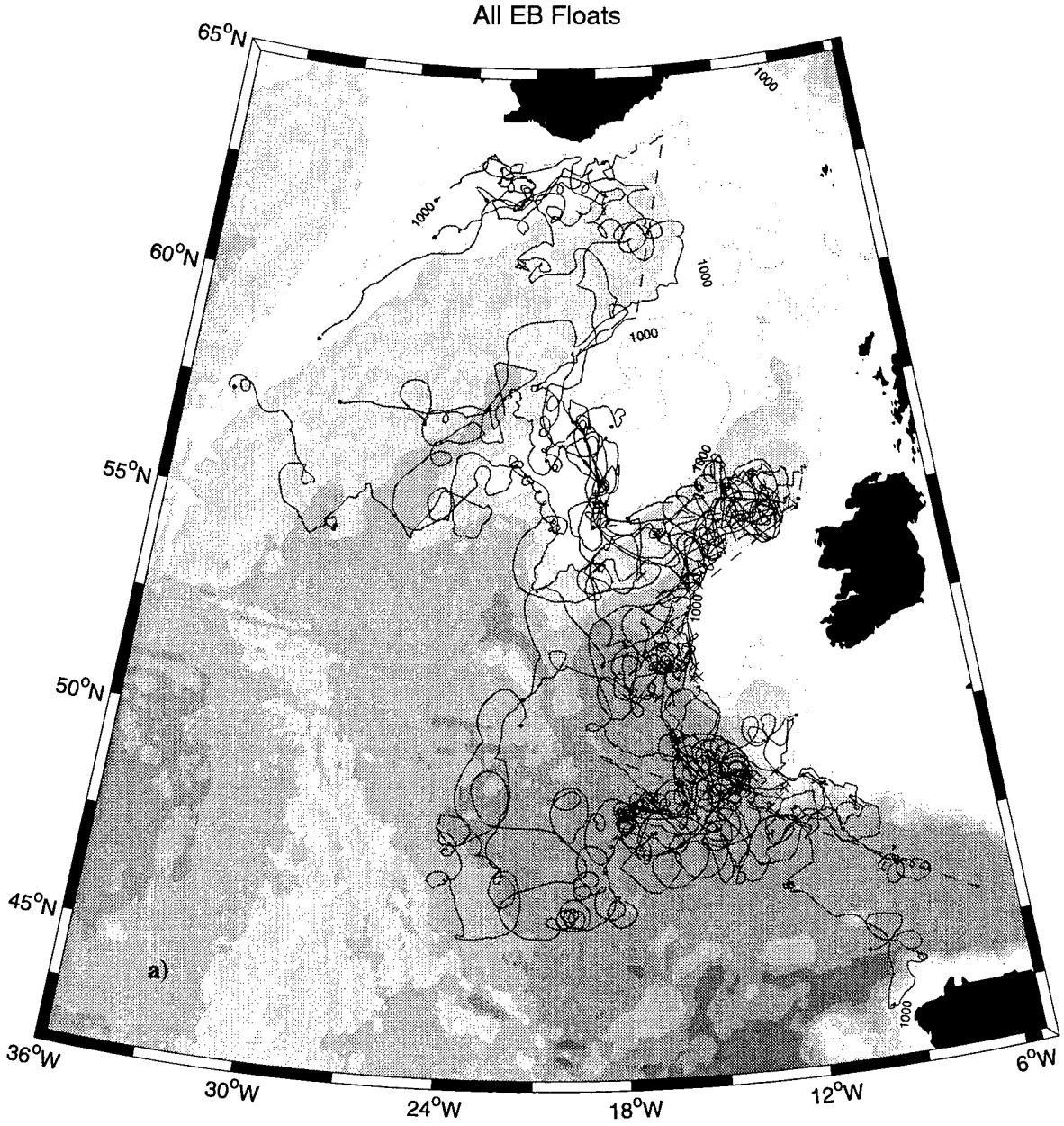
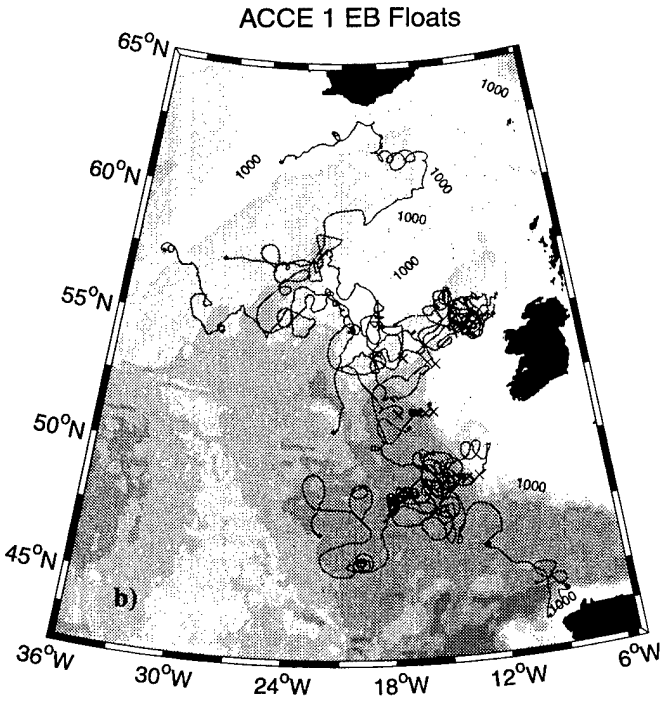


Figure 4. As in Figure 2, but for RAFOS floats launched along the eastern boundary of the Atlantic. a) All RAFOS floats launched along the EB during the WWP experiment.



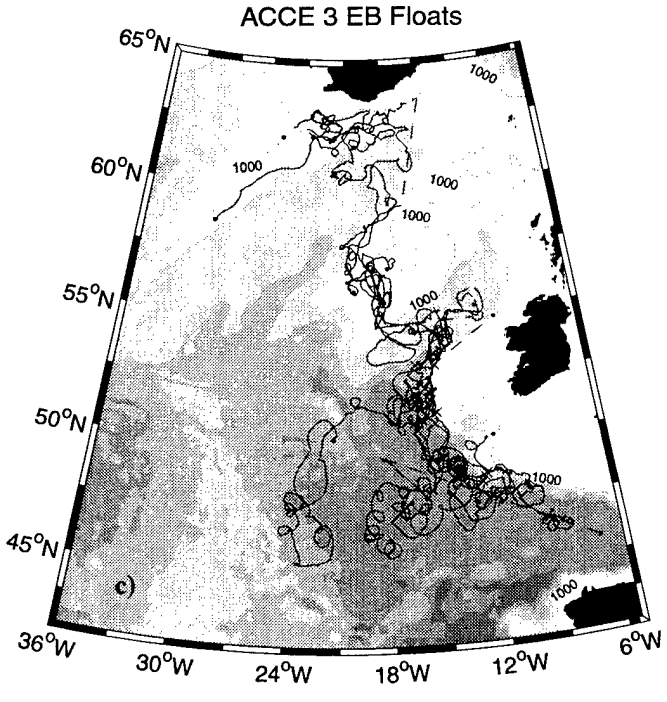


Figure 4, continued. b) EB floats of ACCE 1, and c) EB floats of ACCE 3.

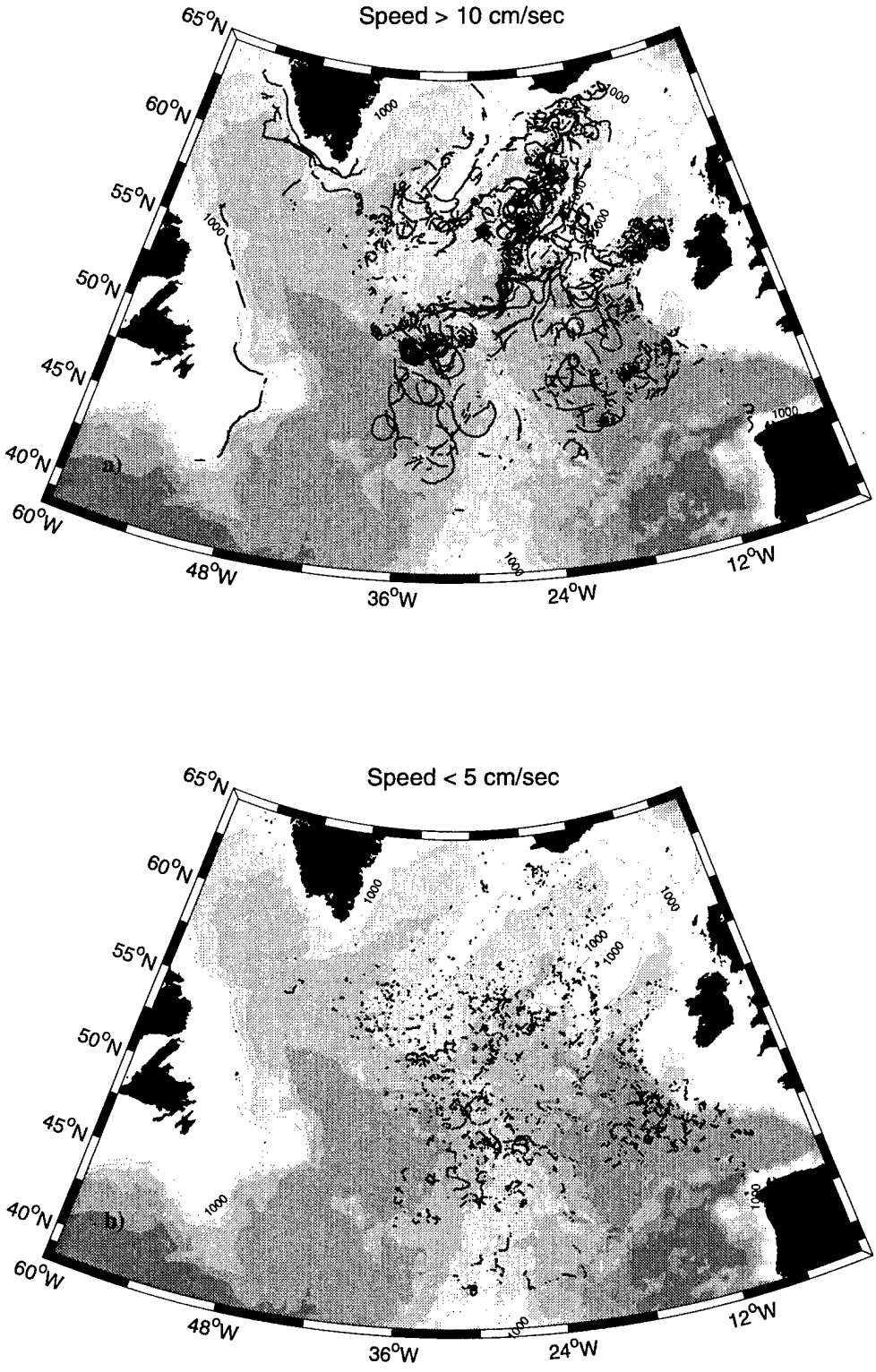


Figure 5. Float track segments with speeds a) greater than 10 cm/sec, and b) slower than 5 cm/sec. Bathymetry as in Figure 1.

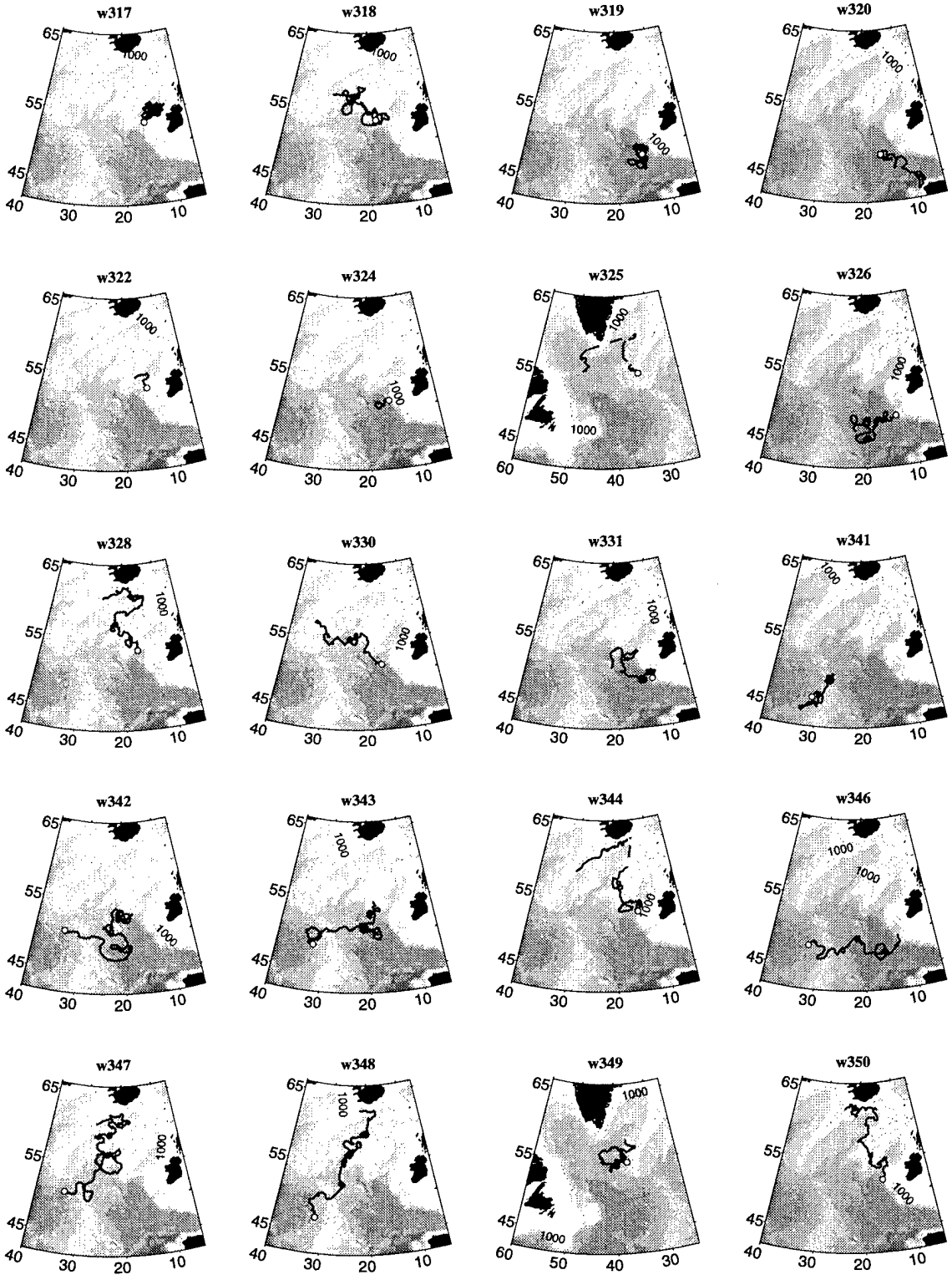


Figure 6. RAFOS float track gallery. Each tracked float is presented with bathymetry as in Figure 1. The launch position of each float is marked with a black-outlined white dot. Untrackable segments are drawn with a dashed line, trackable with a solid line. The float tracks are presented within three possible latitude/longitude limits depending on float location: 42-66N 5-40W, 42-66N 25-60W, or 32-56N 5-40W.

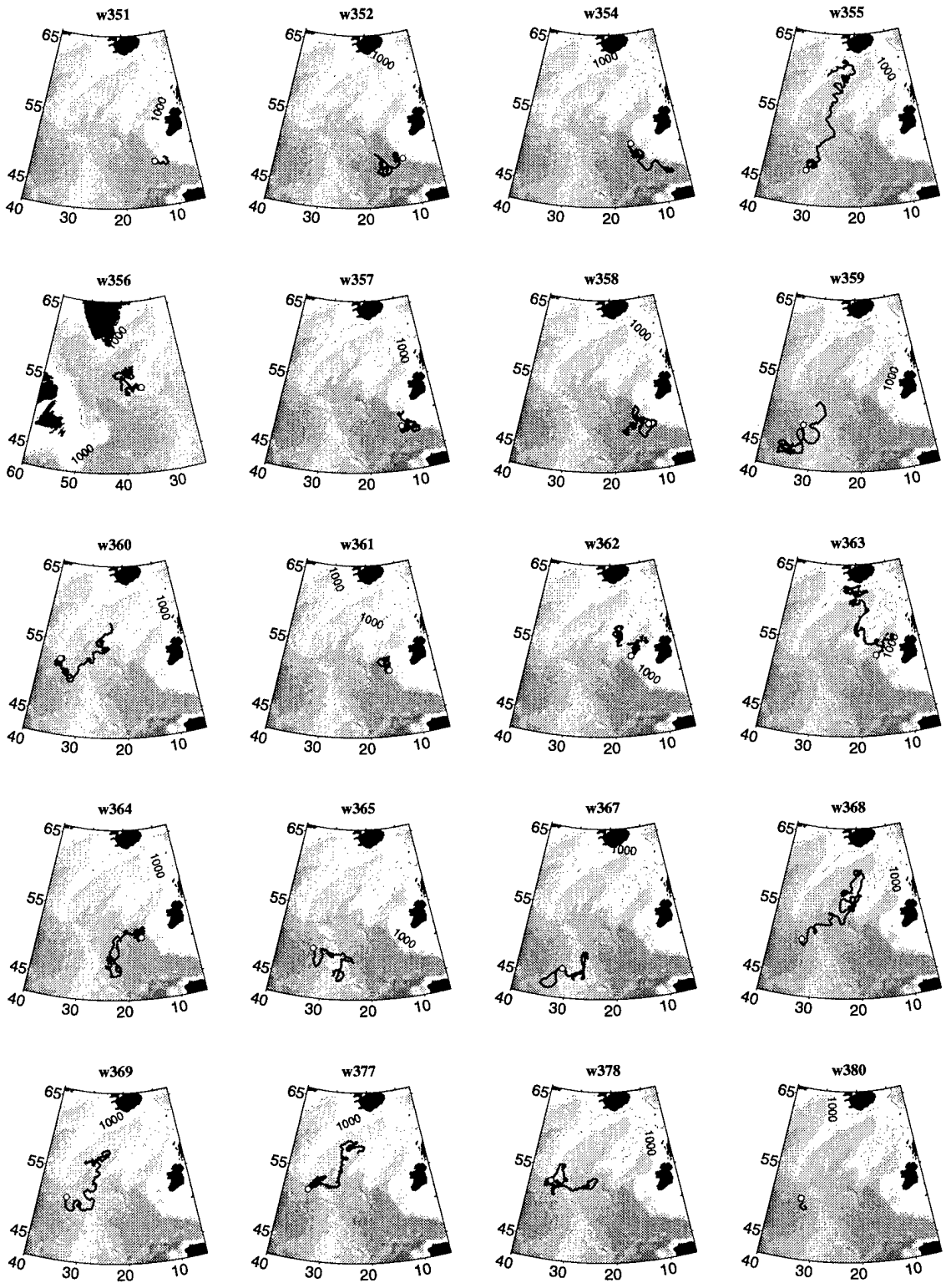


Figure 6, continued.

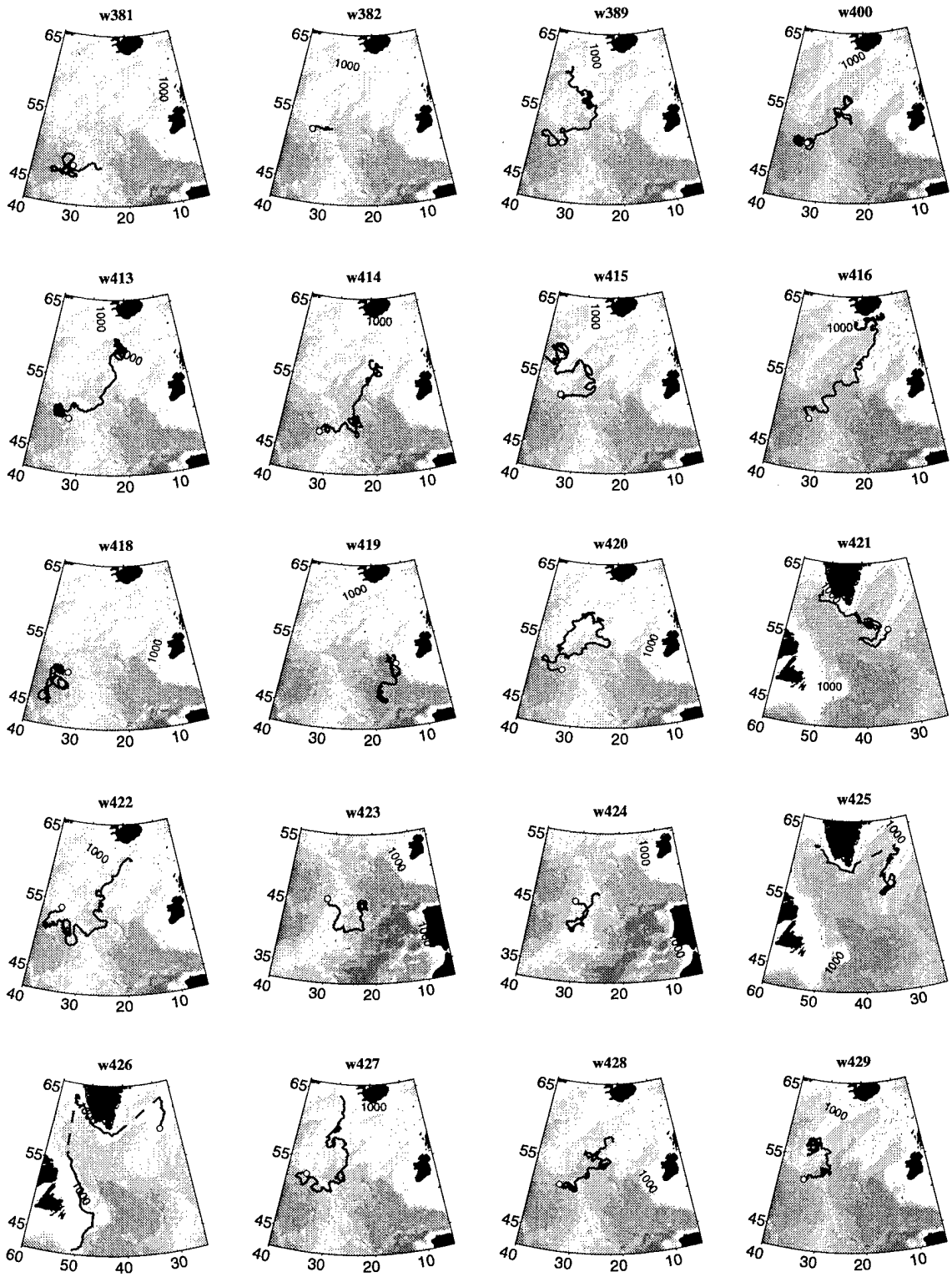
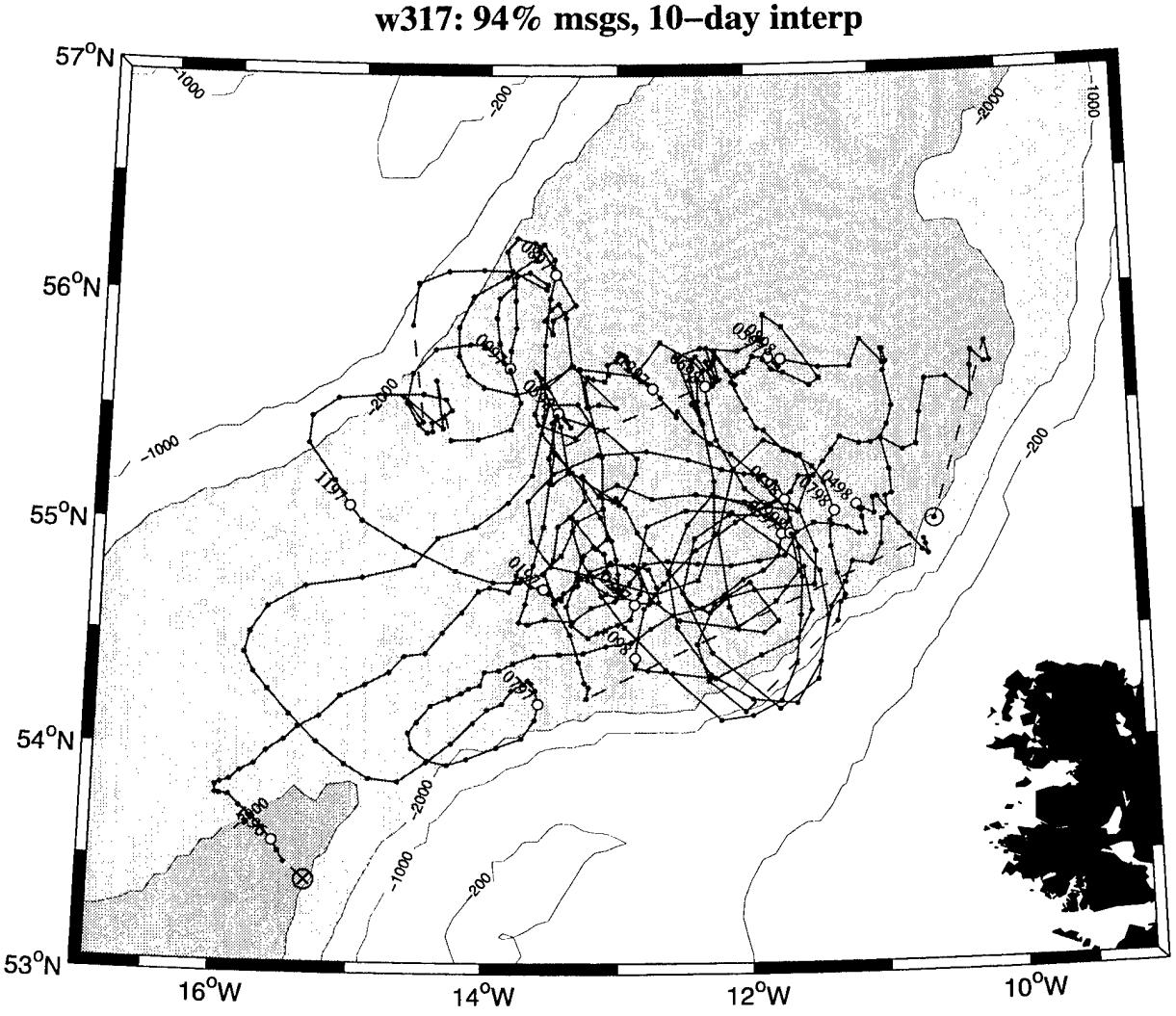
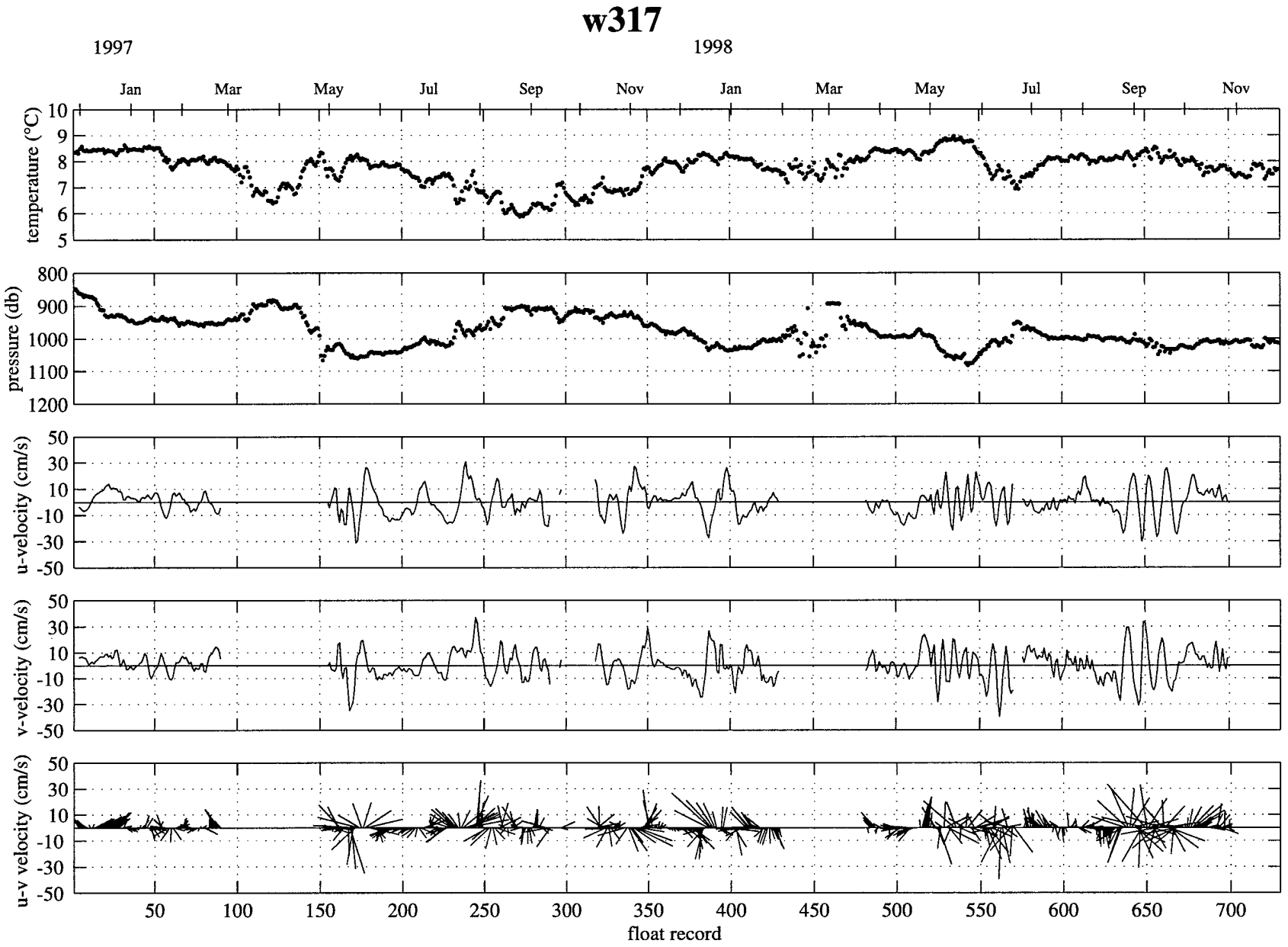


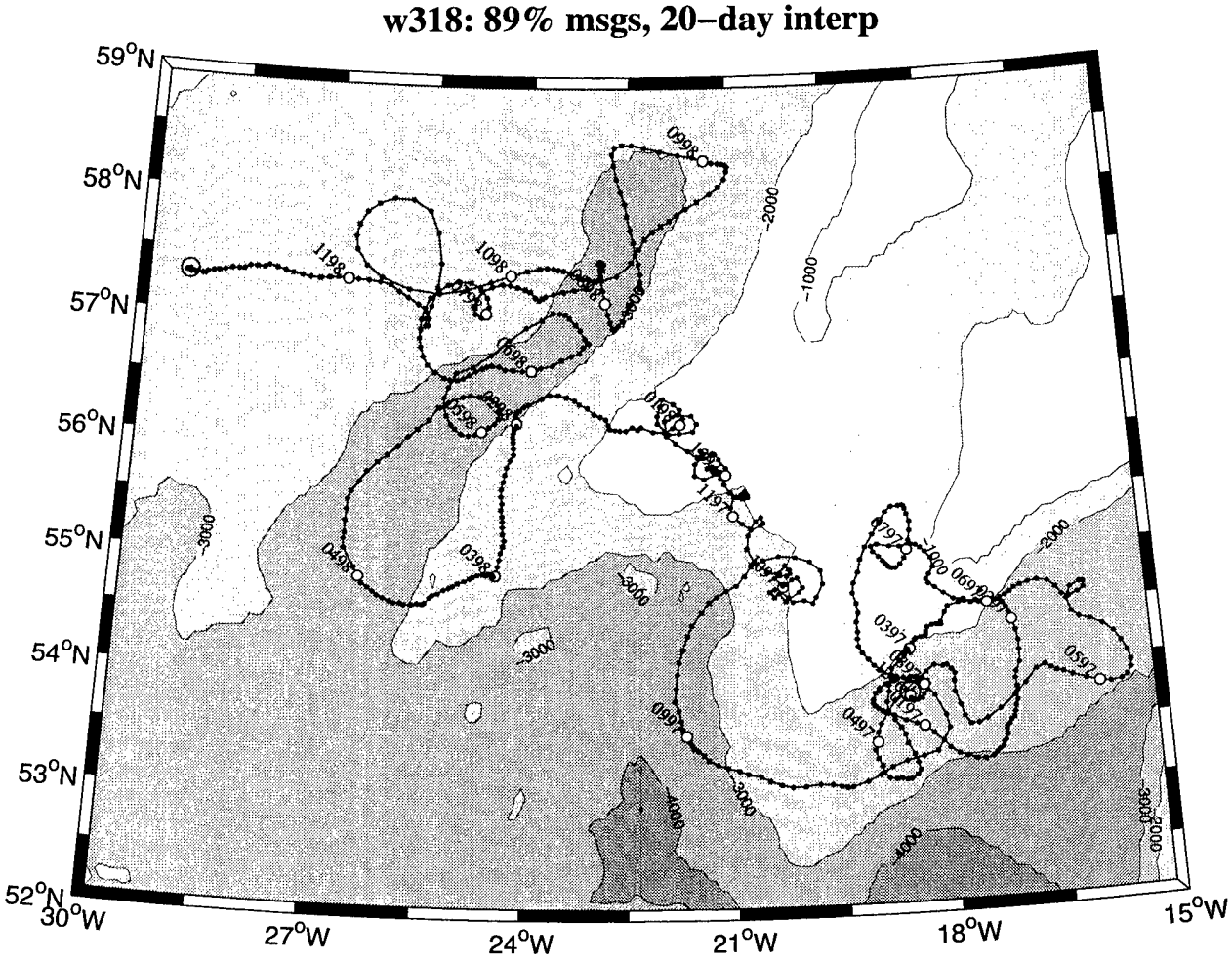
Figure 6, continued.

Appendix B

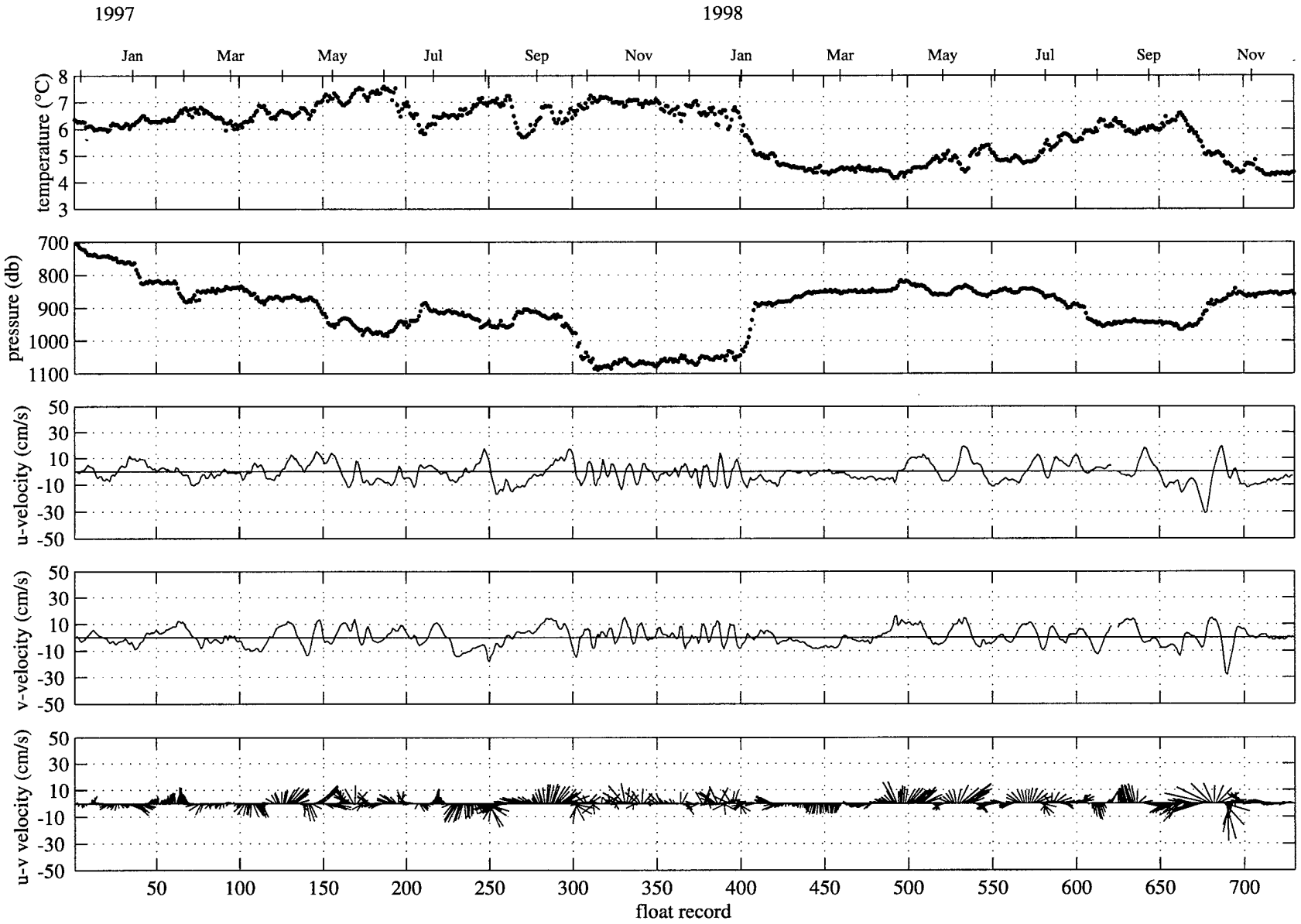
Individual float trajectories and property plots. For each individual float, the track is shown in one figure and property plots in a companion figure. Track plot bathymetry is drawn and shaded in 1000-meter intervals, and the 200-meter isobath is also drawn. Daily positions are marked with black dots, and monthly positions are marked as larger white dots, with 'mmyy', marking the first of each month, adjacent to the white markers. Untrackable segments are drawn with a dashed line. Launch position is drawn with a circle-x; surface with a circle-dot. The title on each trajectory plot includes the float name, the percent messages received from Service Argos, and the interpolation interval used in tracking. Property plots contain panels depicting temperature, pressure, u-velocity, v-velocity, and stick plots representing velocity magnitude and direction. The lower x-axis marks the float record number, which is once per day, and is as long as the intended mission length of the float (in most cases, 730 days). Y-axis limits for temperature and pressure are set to a 5-degree and 400-dbar ranges, where possible. Y-axis limits for velocity are set to either 25 or 50 cm/sec. Floats w323, w329, and w379 are not presented because these floats did not transmit enough data to track. Launch and surface information for these floats is presented in Table 1. The two ALFOS float tracks are included at the end of Appendix B, presented similarly. The surface track points (every 30 days, while the float transmitted its data) are marked as white triangles.

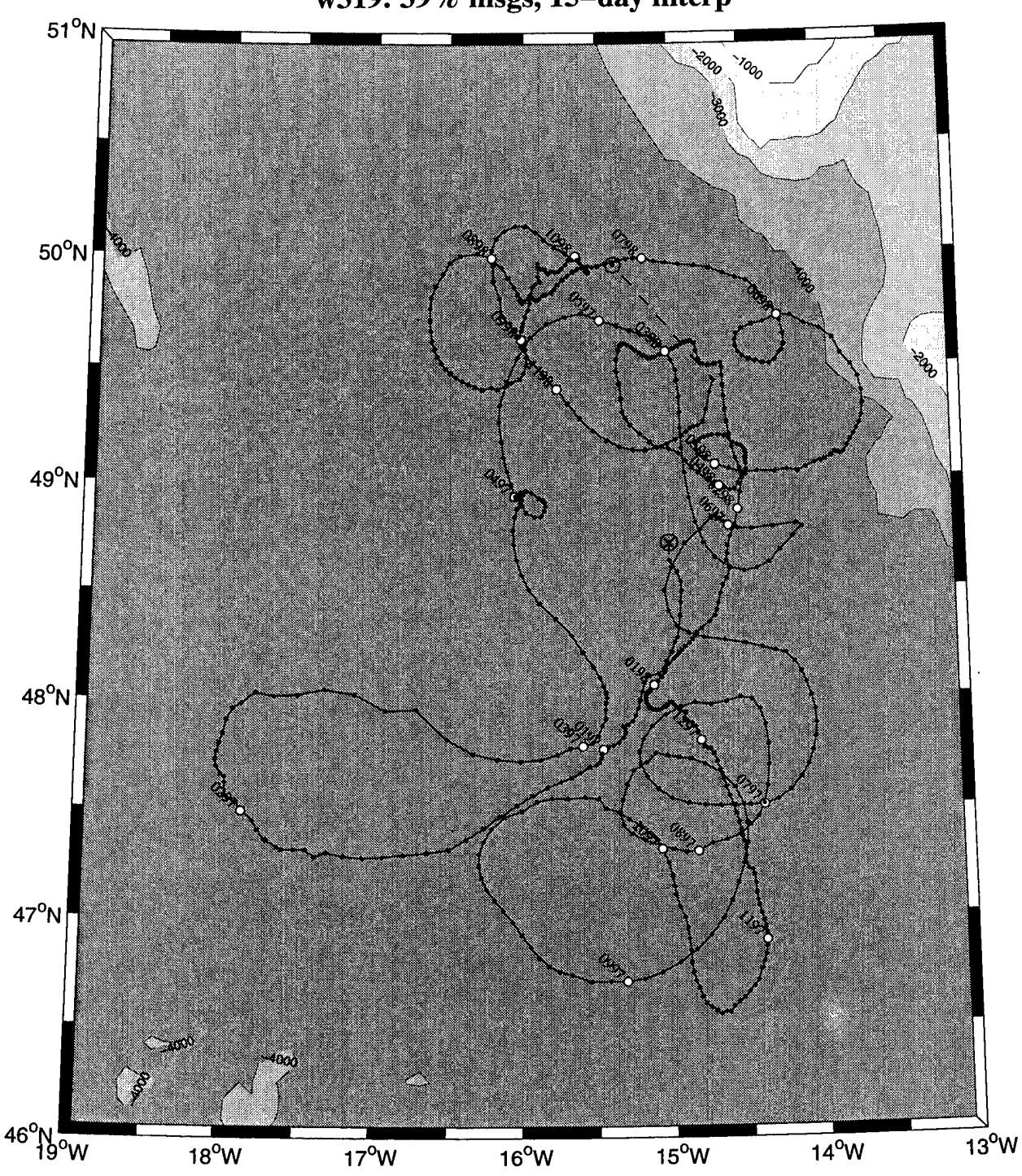

w317: 94% msgs, 10–day interp
57°N
56°N
55°N
54°N
53°N
16°W
14°W
12°W
10°W
-1000
-200
-2000


w317
1997
1998
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
10
9
8
7
6
5
pressure (db)
800
900
1000
1100
1200
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

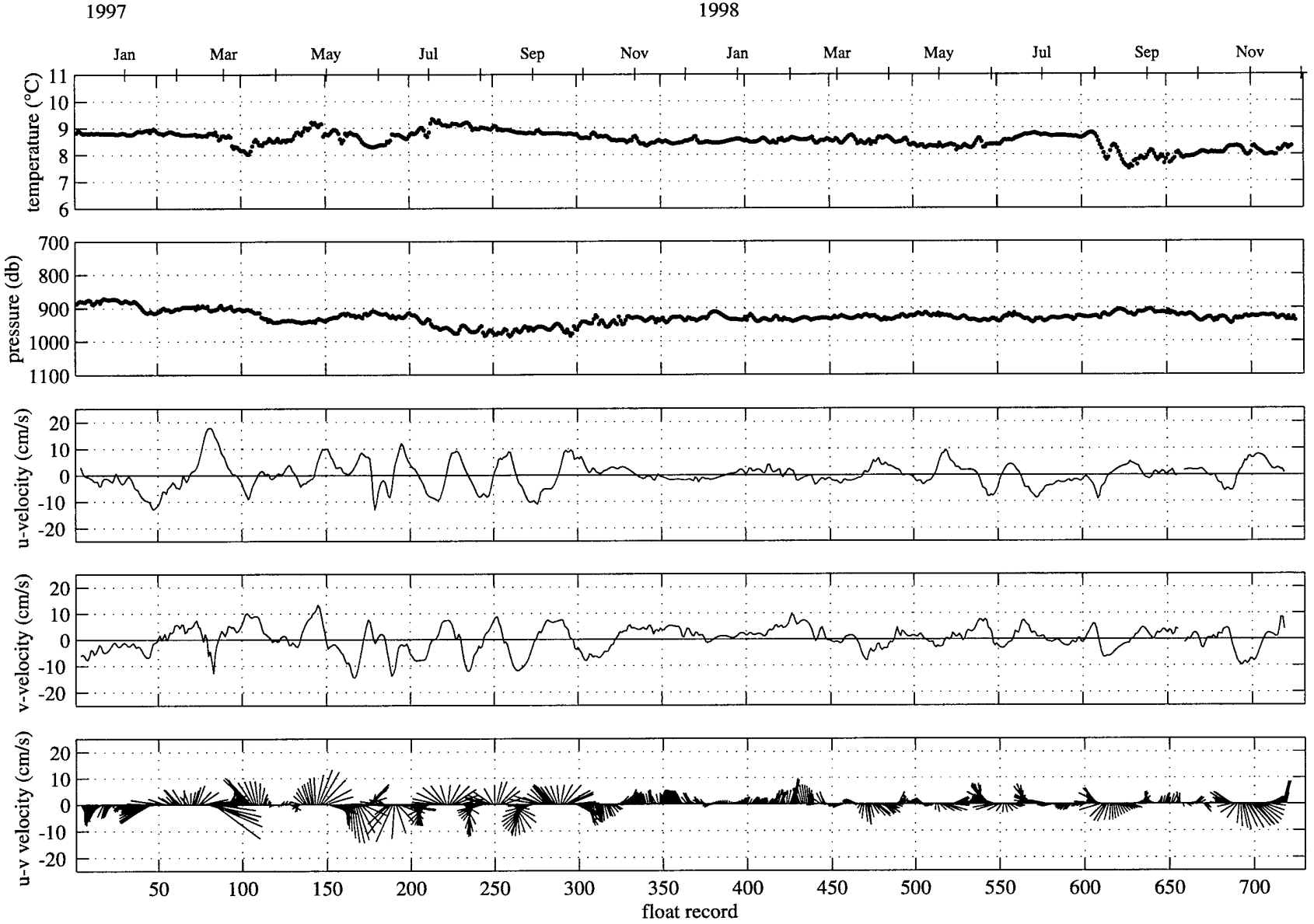

w318: 89% msgs, 20–day interp
59°N
58°N
57°N
56°N
55°N
54°N
53°N
52°N
30°W
27°W
24°W
21°W
18°W
15°W
-2000
-1000
-3000
-4000

w318

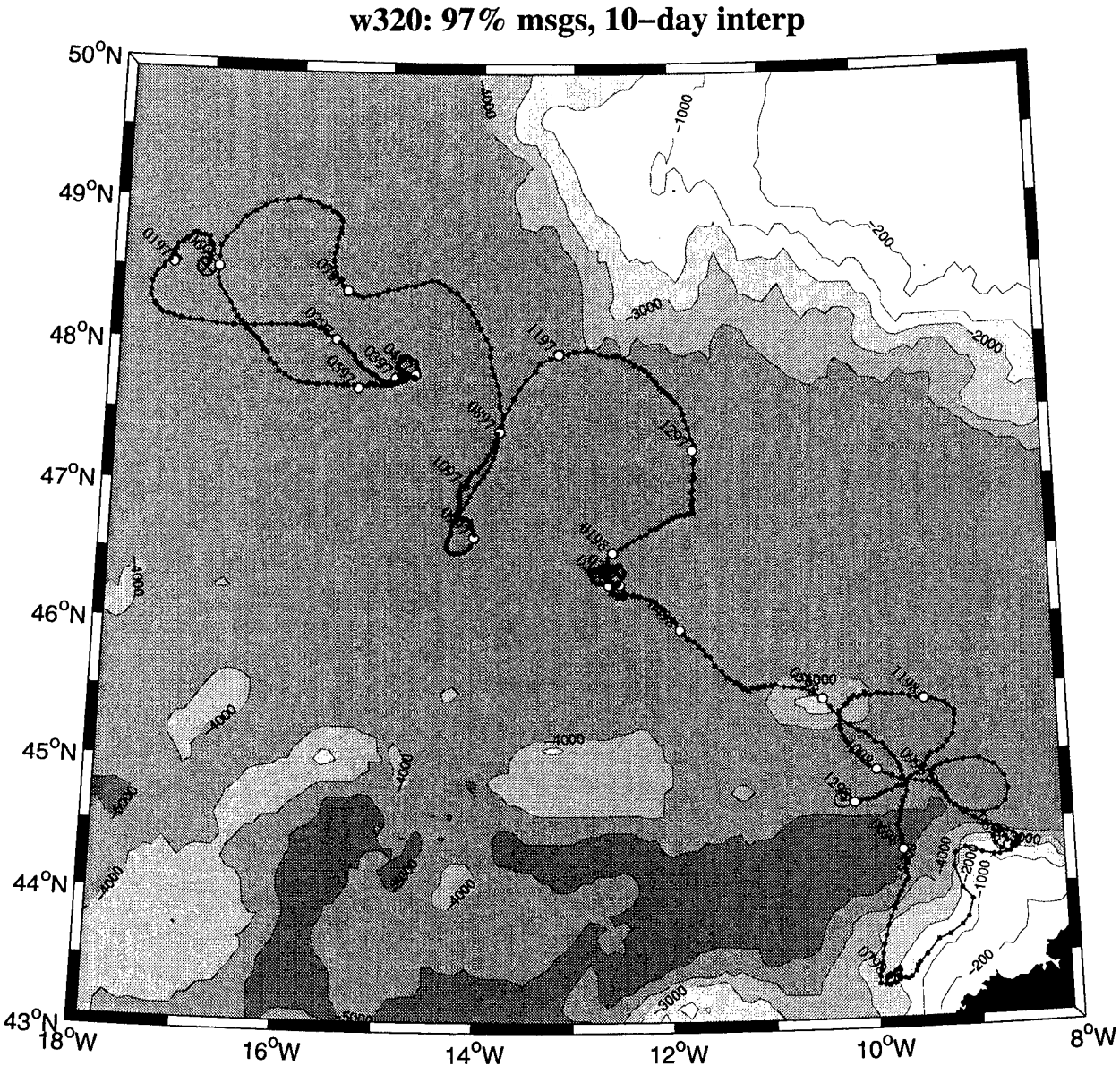

1997
1998
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
8
7
6
5
4
3
pressure (db)
700
800
900
1000
1100
u-velocity (cm/s)
v-velocity (cm/s)
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w319: 39% msgs, 15-day interp
51°N
50°N
49°N
48°N
47°N
46°N
19°W
18°W
17°W
16°W
15°W
14°W
13°W
-1000
-2000
-3000
-4000

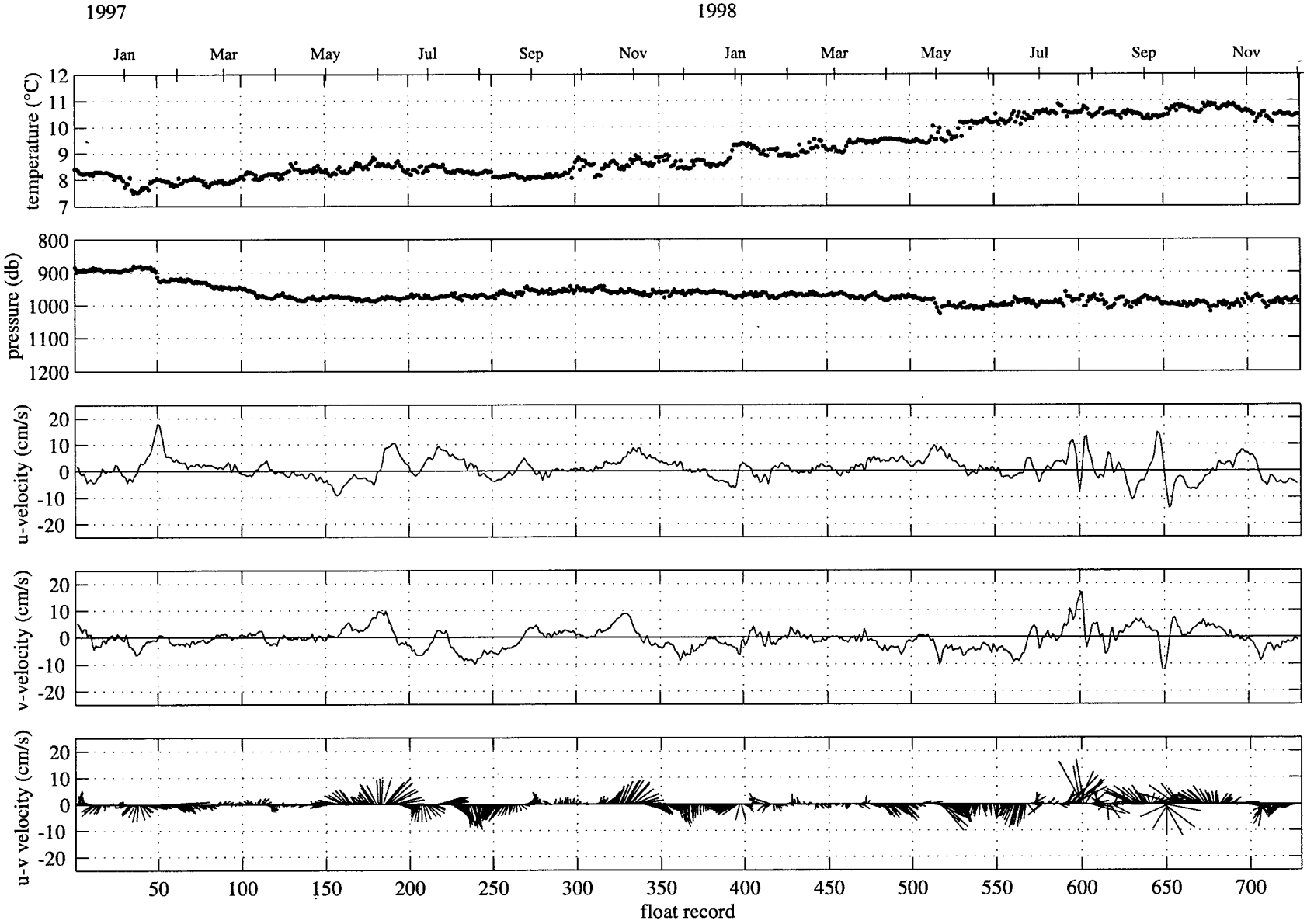
w319

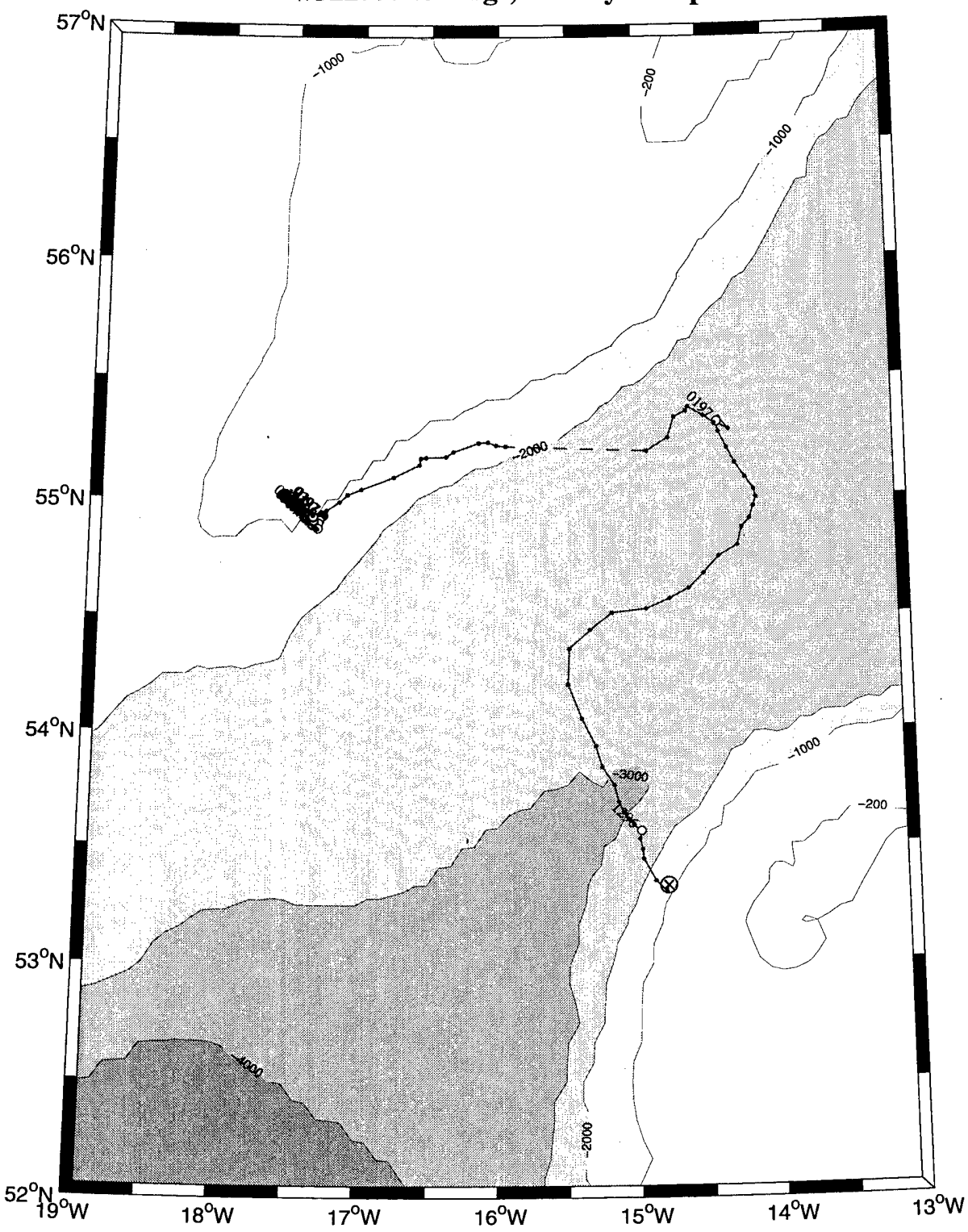

1997
1998
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
11
10
9
8
7
6
pressure (db)
700
800
900
1000
1100
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w320: 97% msgs, 10–day interp

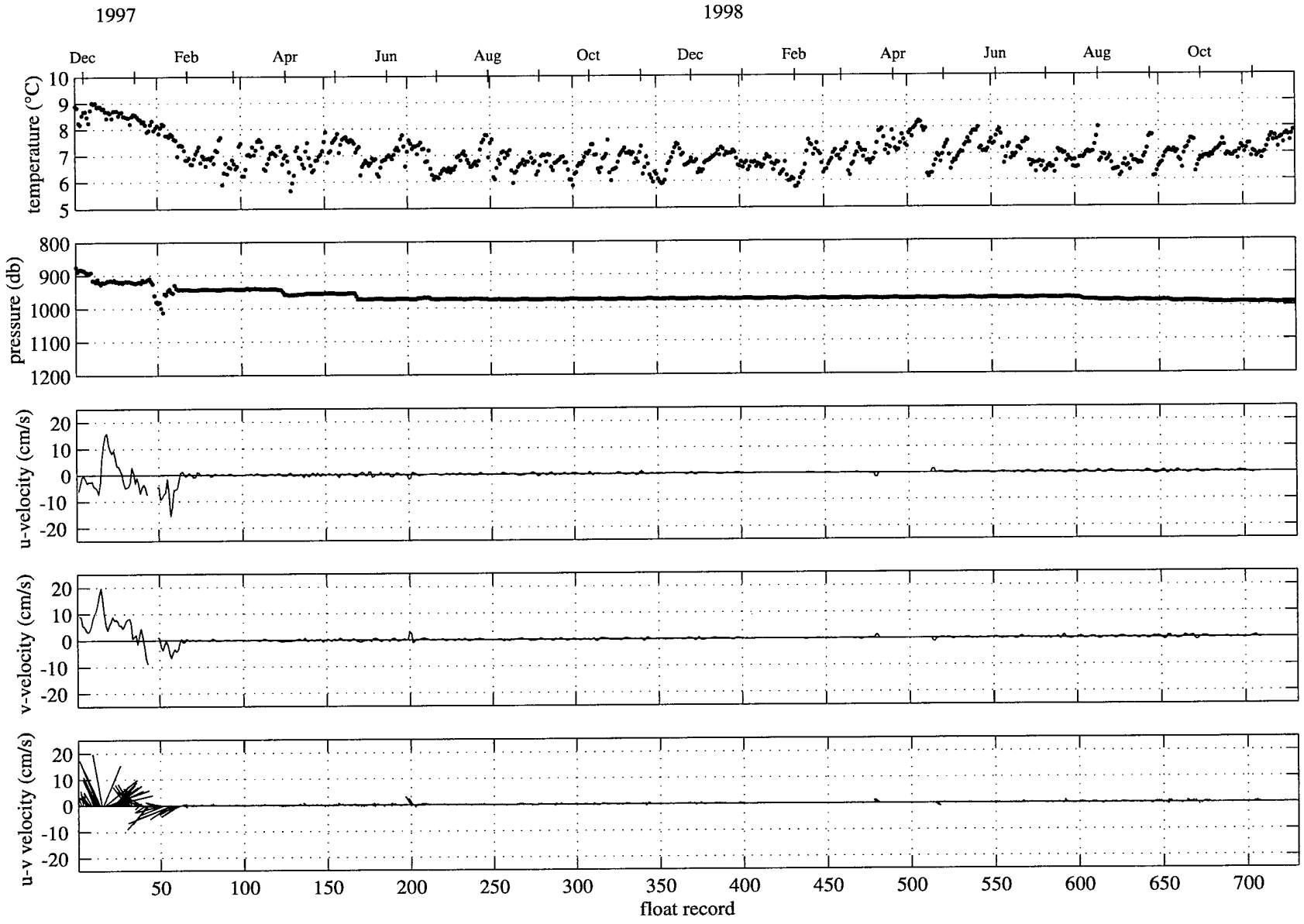


w320

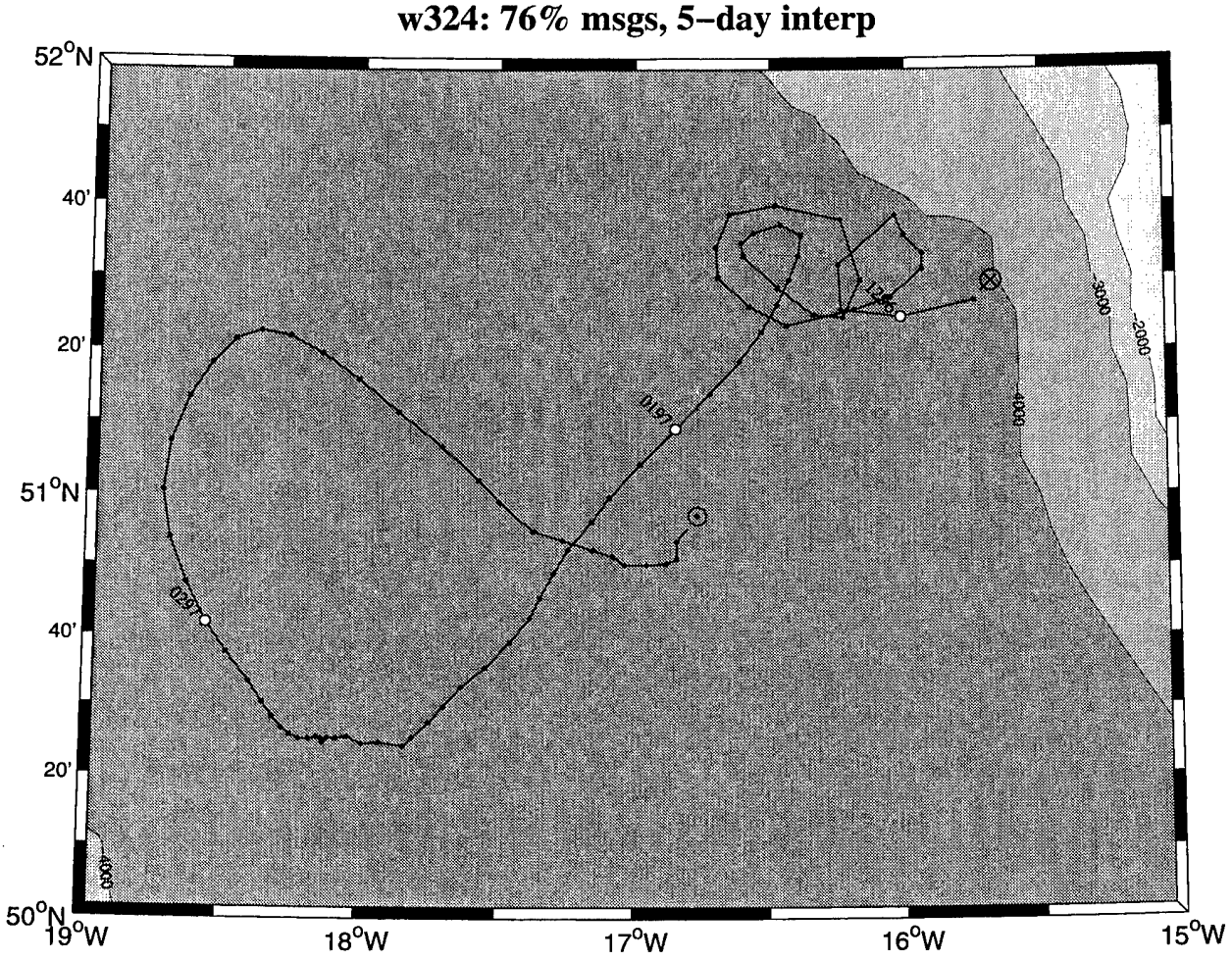

1997
1998
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
12
11
10
9
8
7
pressure (db)
800
900
1000
1100
1200
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w322: 99% msgs, 20–day interp
57°N
56°N
55°N
54°N
53°N
52°N
19°W
18°W
17°W
16°W
15°W
14°W
13°W
-1000
-200
-2000
-3000
-4000

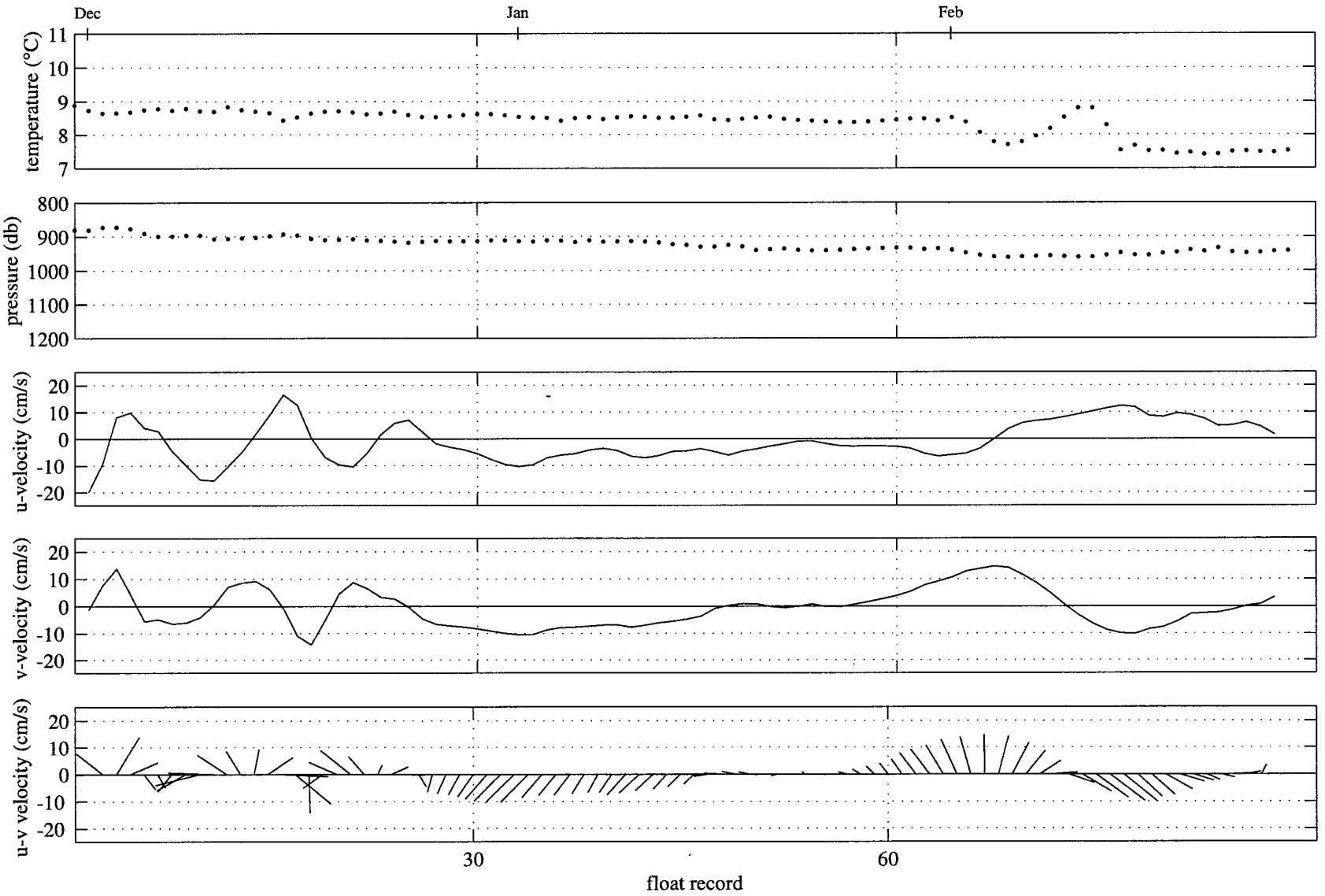
w322

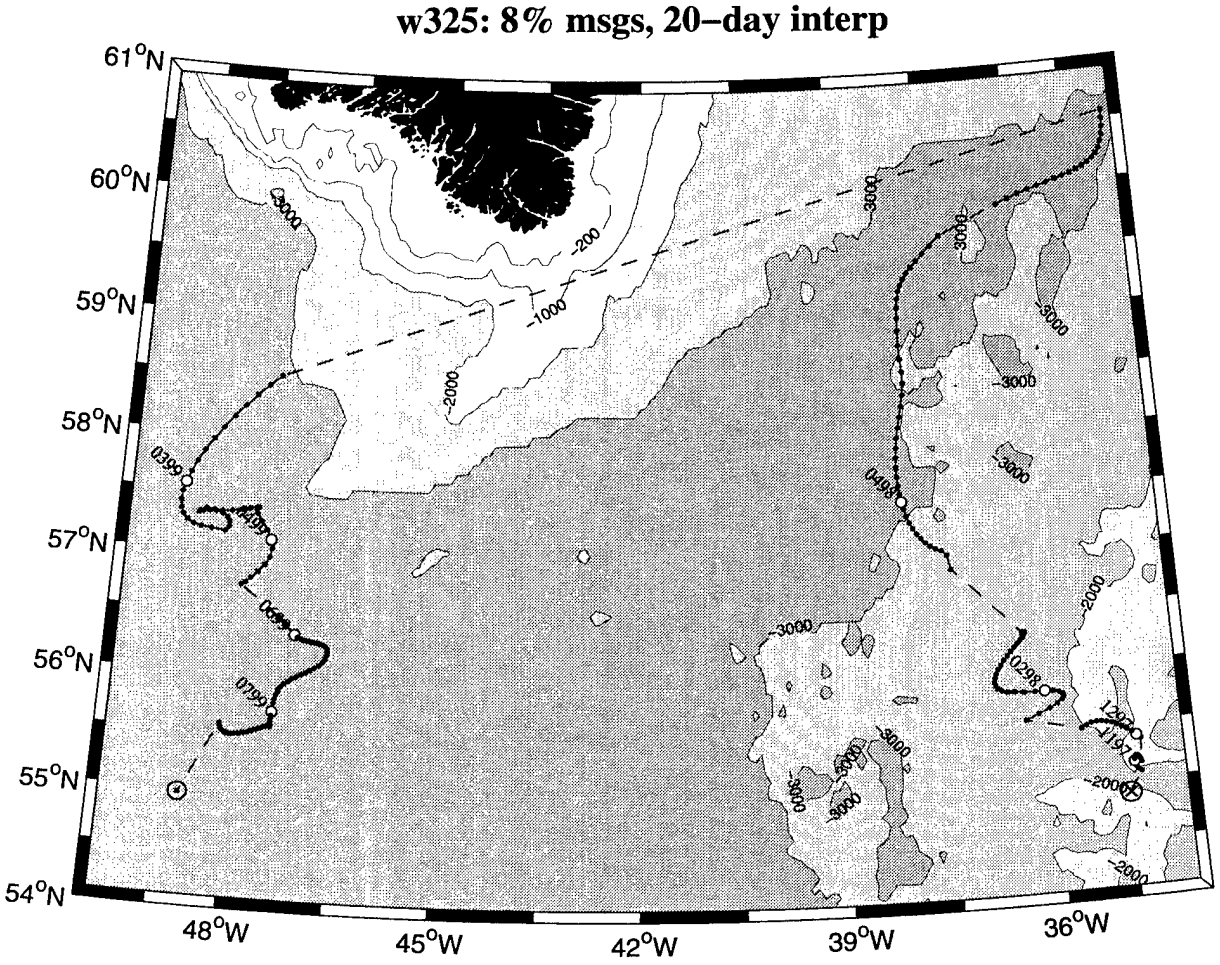

1997
1998
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
10
9
8
7
6
5
pressure (db)
800
900
1000
1100
1200
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w324: 76% msgs, 5–day interp

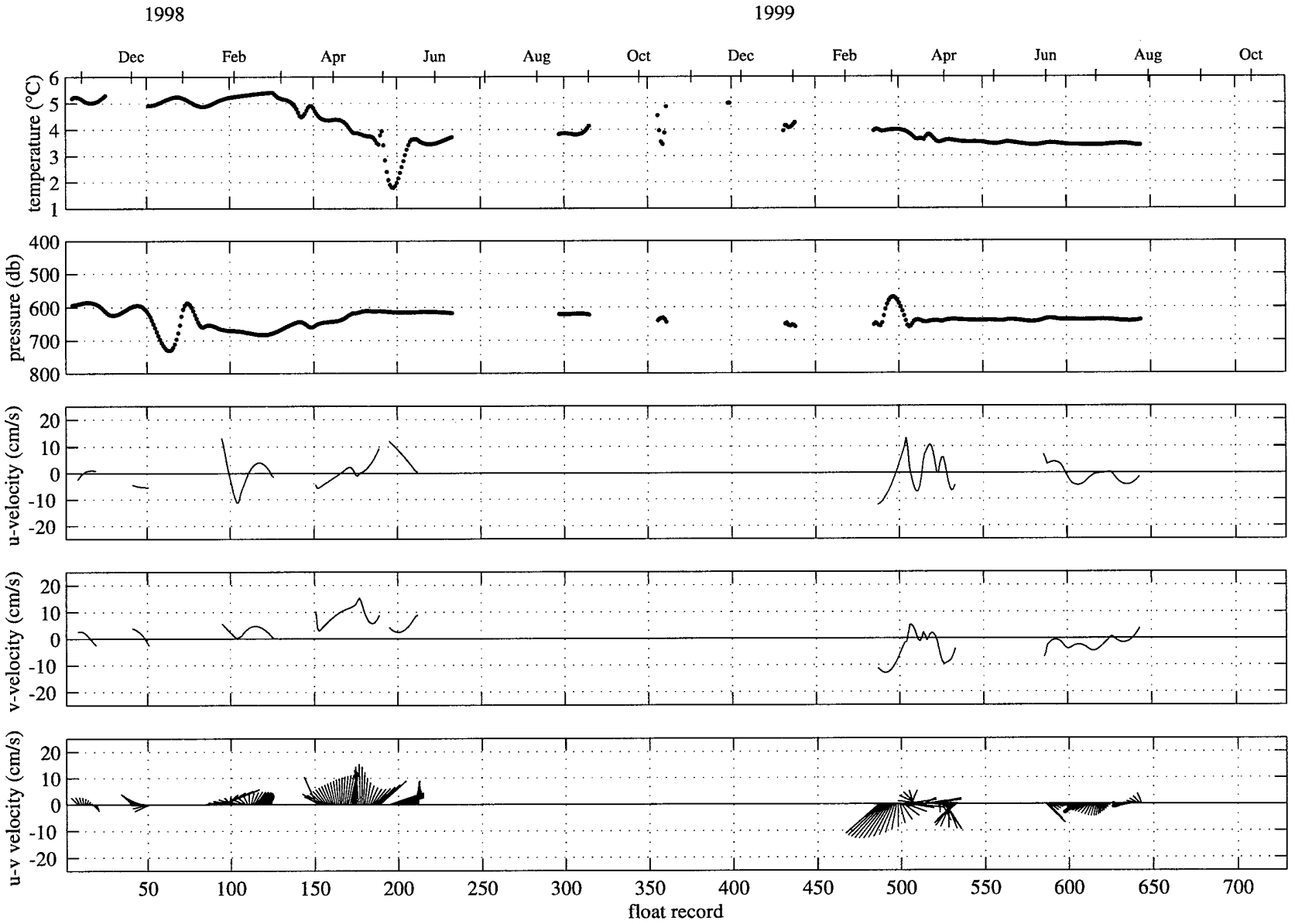


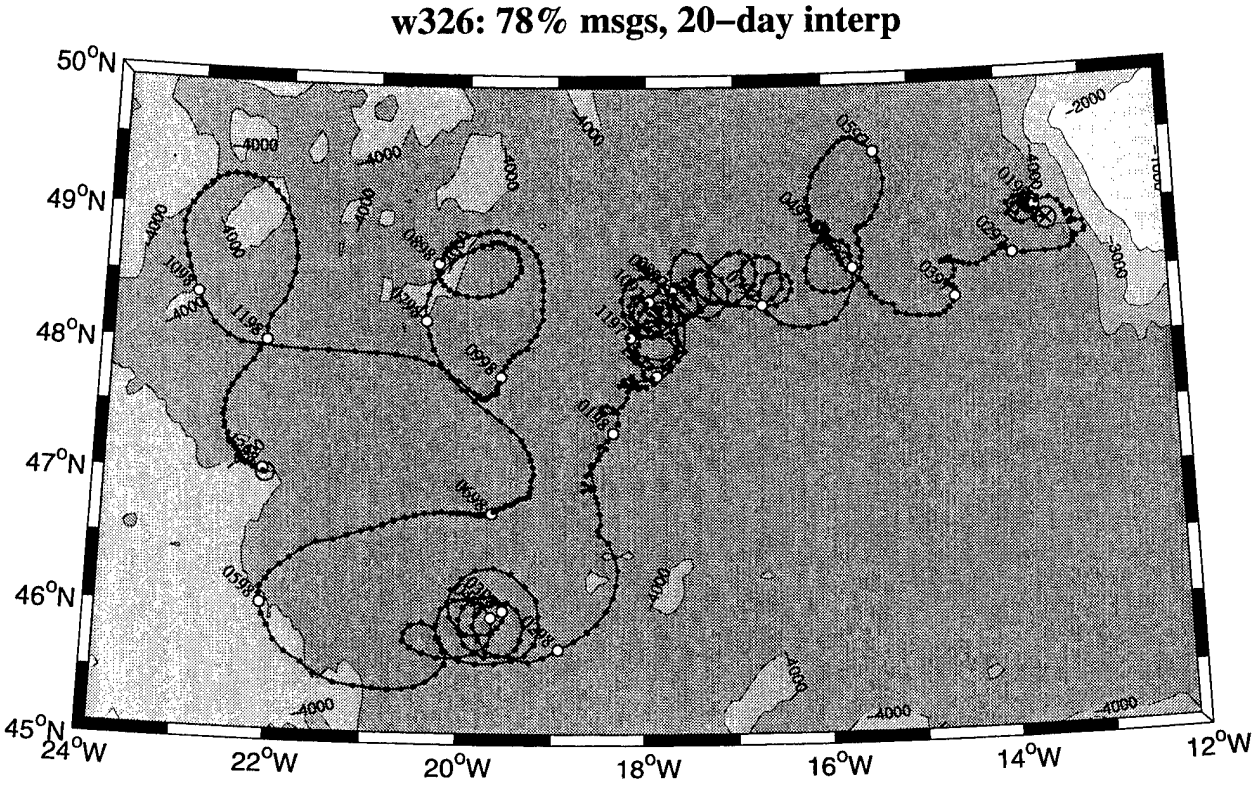
w324


1997
Dec
Jan
Feb
temperature (°C)
11
10
9
8
7
pressure (db)
800
900
1000
1100
1200
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
30
60
float record

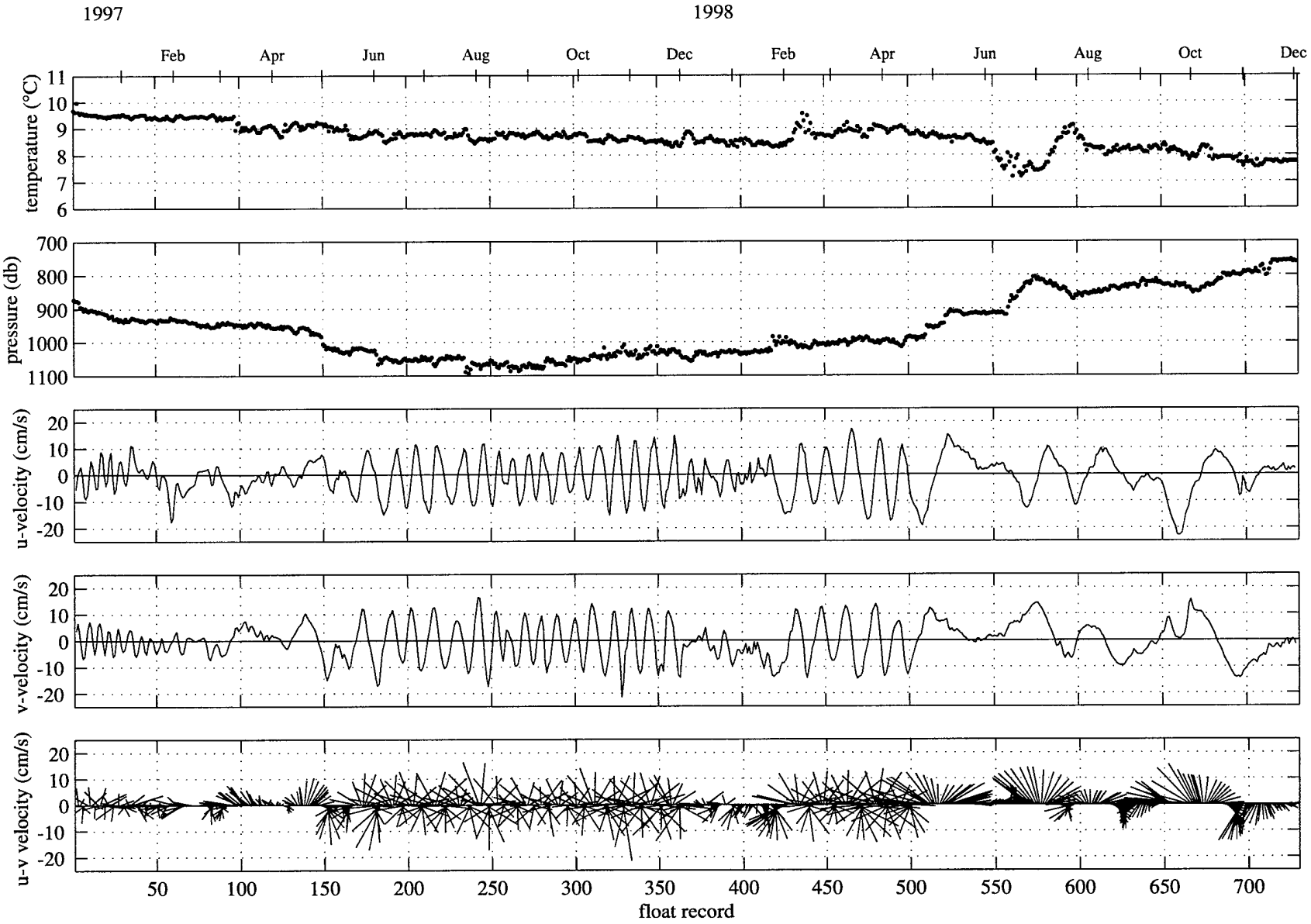

w325: 8% msgs, 20–day interp
61°N
60°N
59°N
58°N
57°N
56°N
55°N
54°N
48°W
45°W
42°W
39°W
36°W
-200
-1000
-2000
-3000
0399
0469
0539
0609
0679
0749
0819
0889
0959
1029
1099
1169
1239
1309

w325

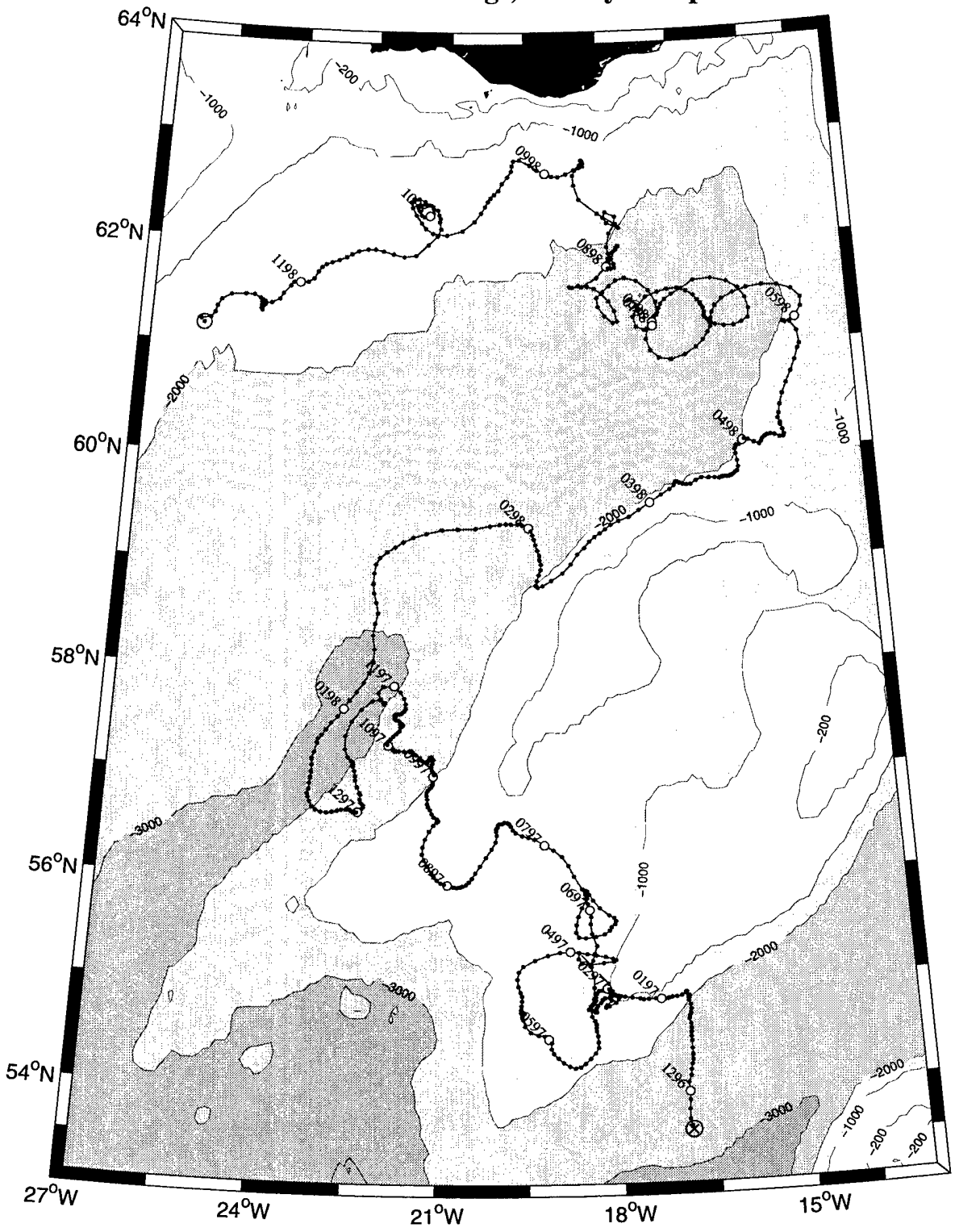

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
6
5
4
3
2
1
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w326: 78% msgs, 20–day interp
50°N
49°N
48°N
47°N
46°N
45°N
24°W
22°W
20°W
18°W
16°W
14°W
12°W

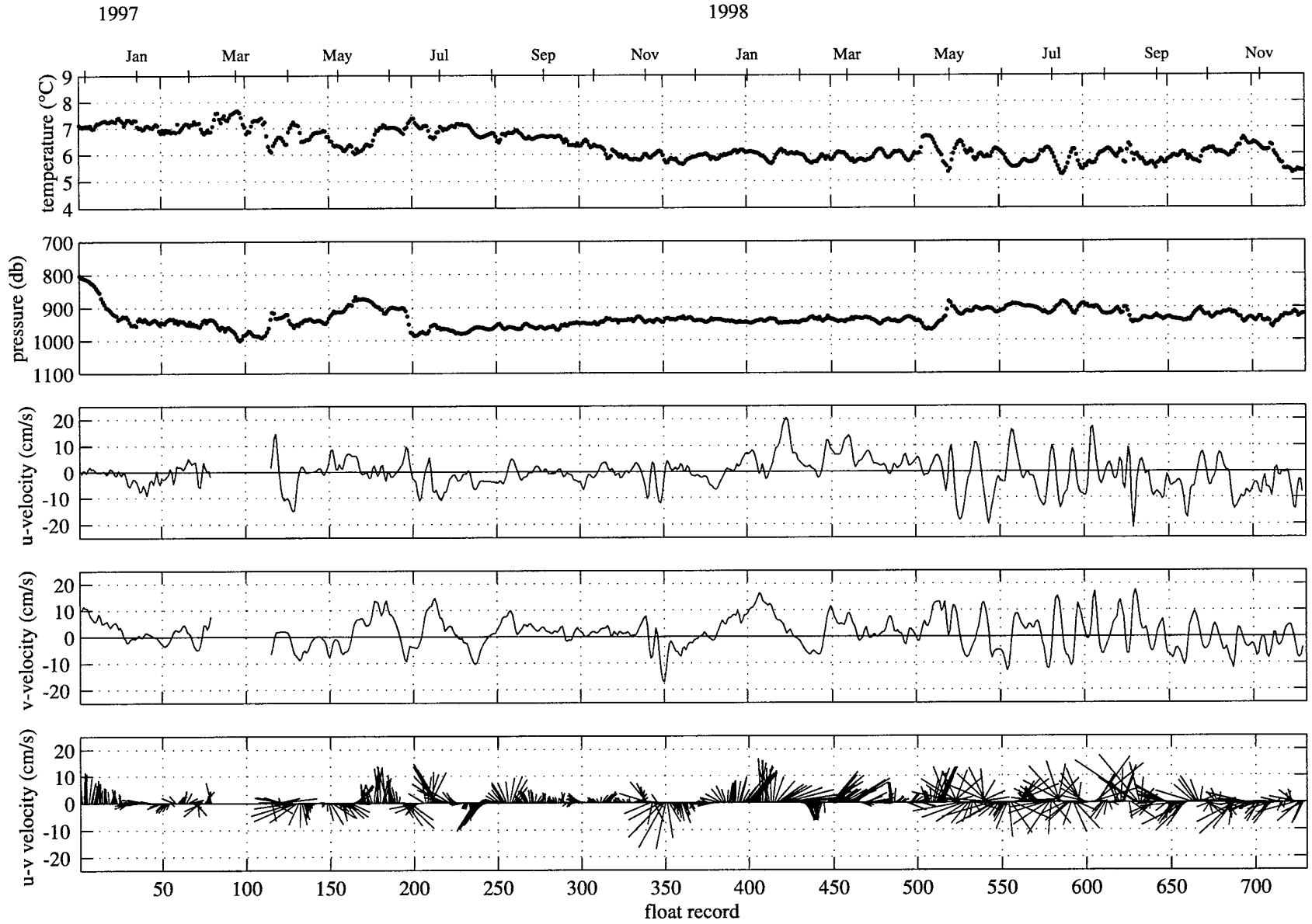
w326

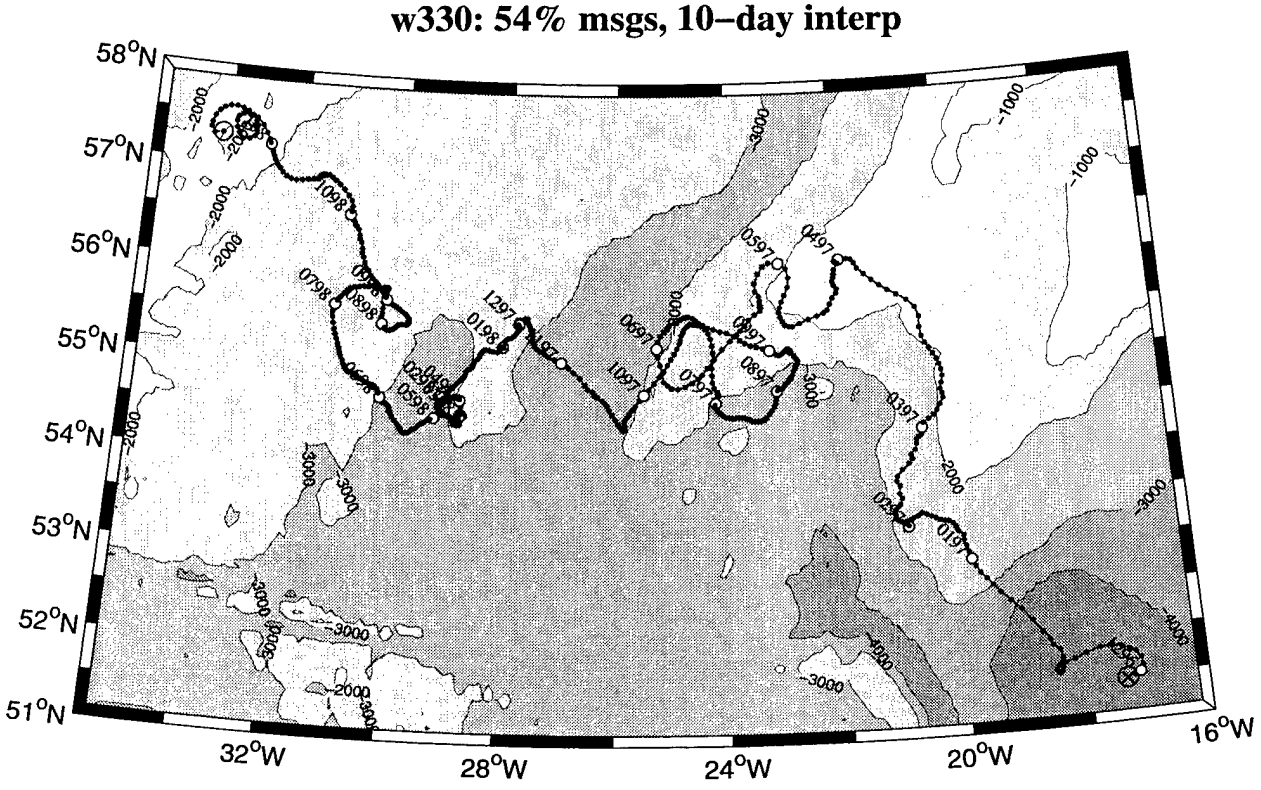

1997
1998
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
Dec
temperature (°C)
11
10
9
8
7
6
pressure (db)
700
800
900
1000
1100
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w328: 73% msgs, 20–day interp

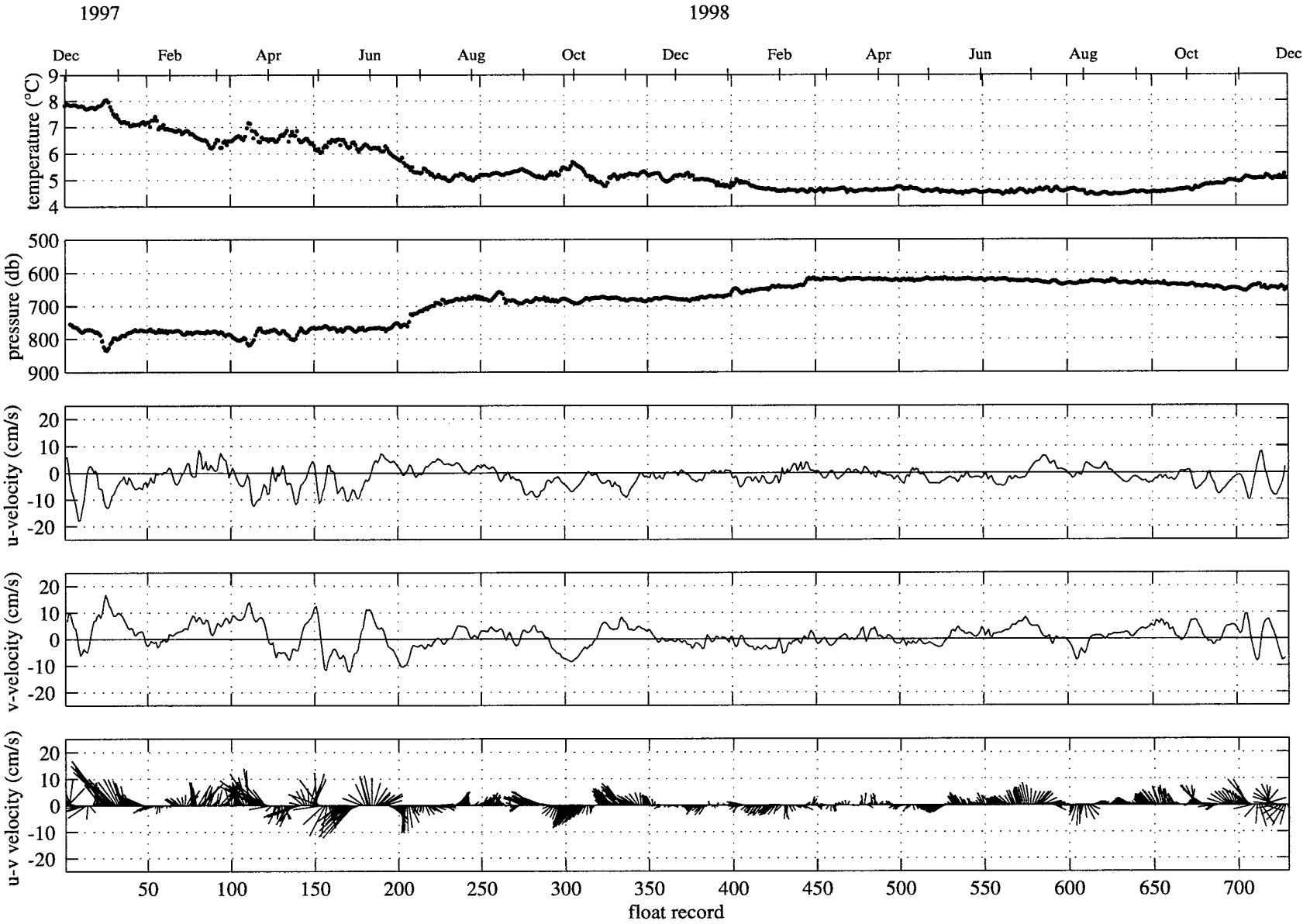


w328

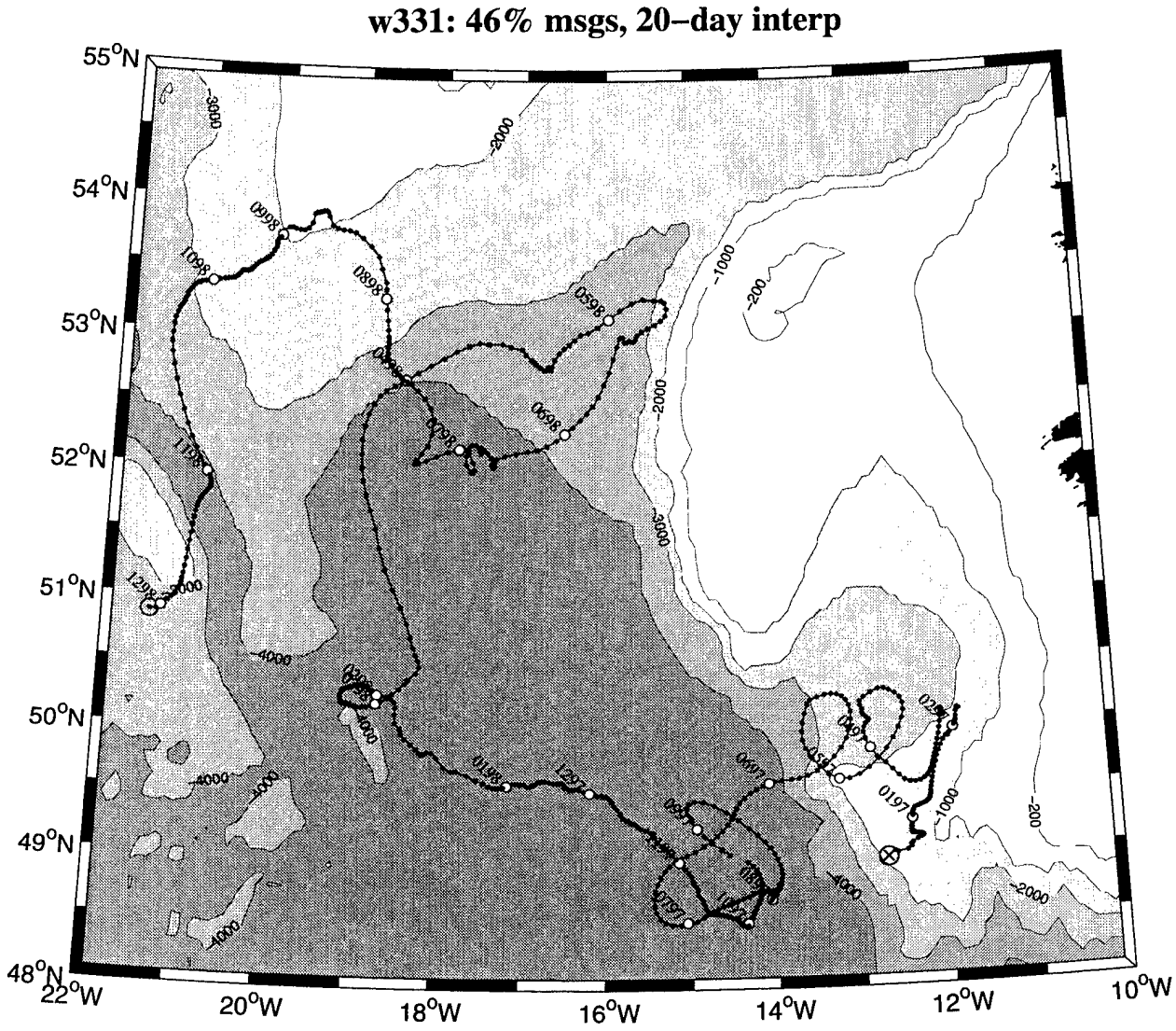

1997
1998
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
9
8
7
6
5
4
pressure (db)
700
800
900
1000
1100
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w330: 54% msgs, 10–day interp
58°N
57°N
56°N
55°N
54°N
53°N
52°N
51°N
32°W
28°W
24°W
20°W
16°W

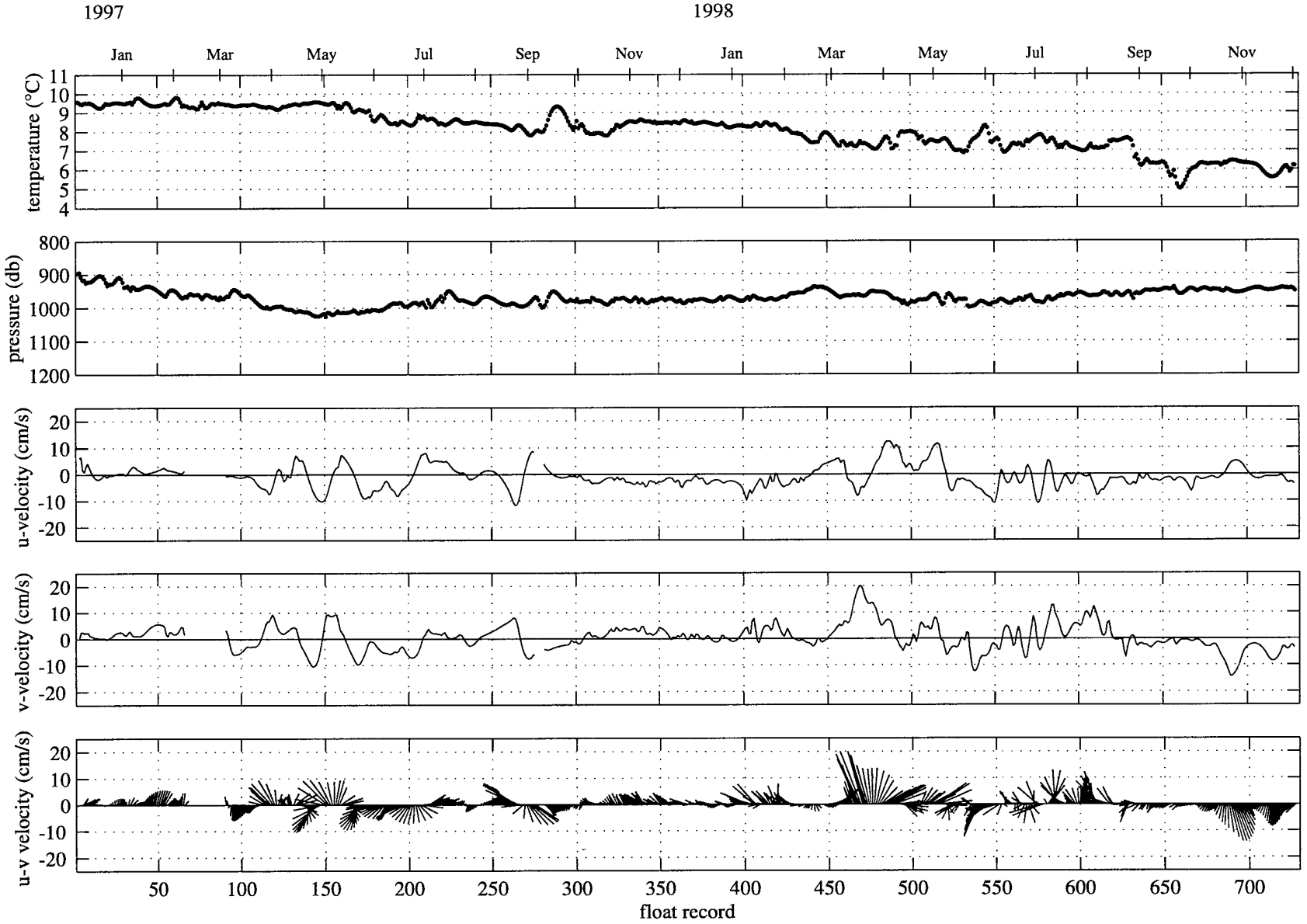
w330

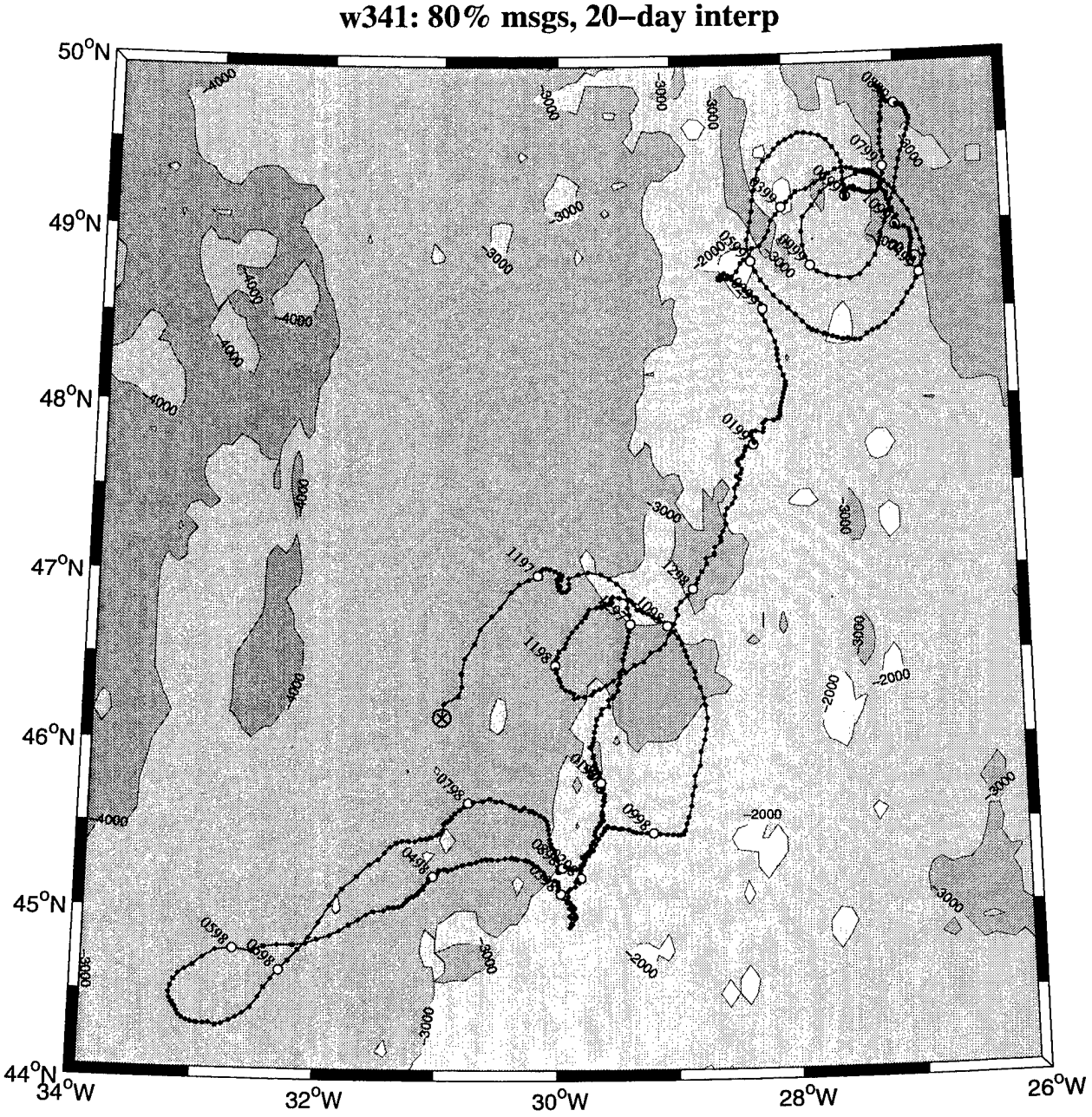

1997
1998
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
Dec
temperature (°C)
9
8
7
6
5
4
pressure (db)
500
600
700
800
900
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w331: 46% msgs, 20–day interp

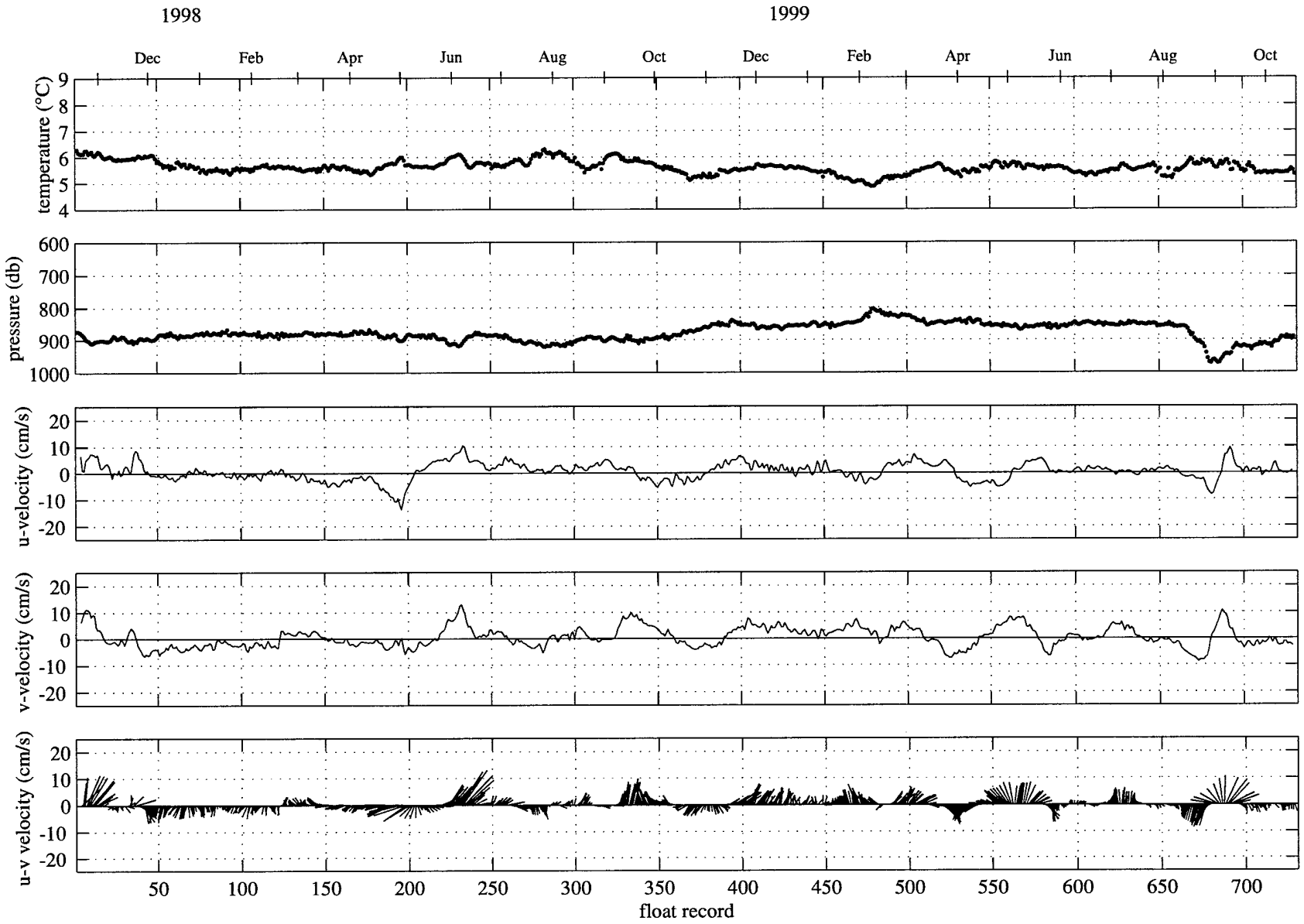


w331

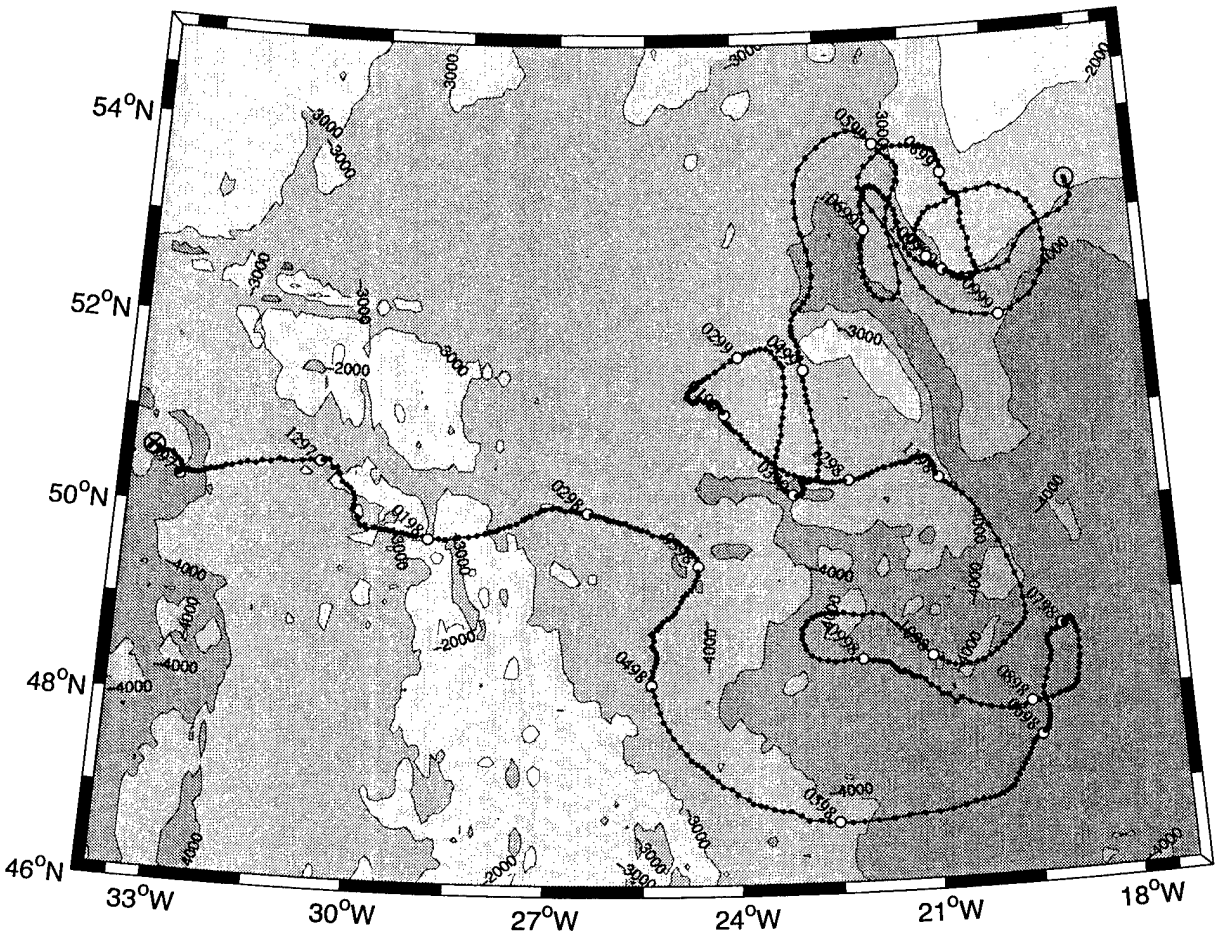

1997
1998
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
pressure (db)
u-velocity (cm/s)
v-velocity (cm/s)
u-v velocity (cm/s)
float record


w341: 80% msgs, 20–day interp
50°N
49°N
48°N
47°N
46°N
45°N
44°N
34°W
32°W
30°W
28°W
26°W

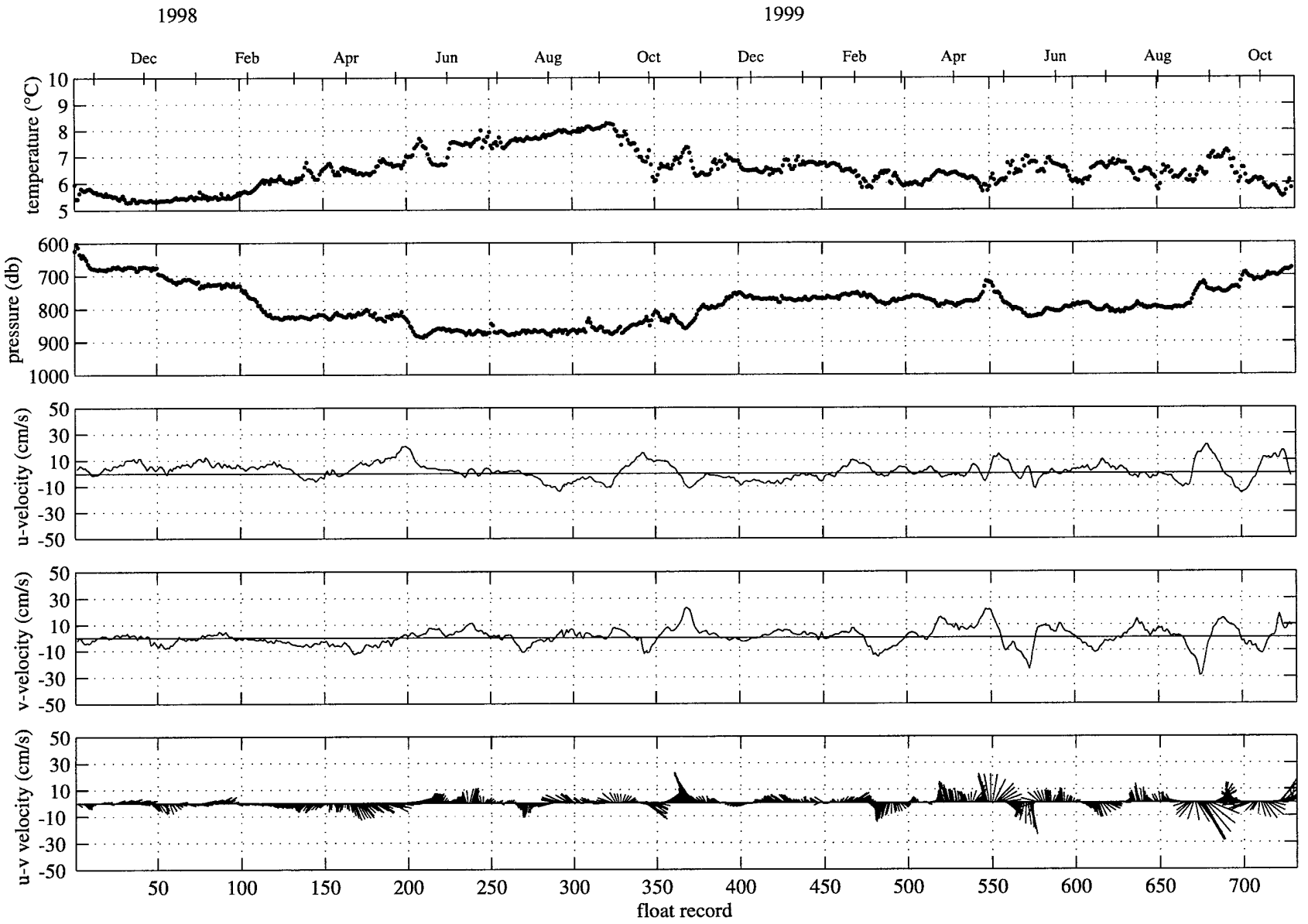
w341

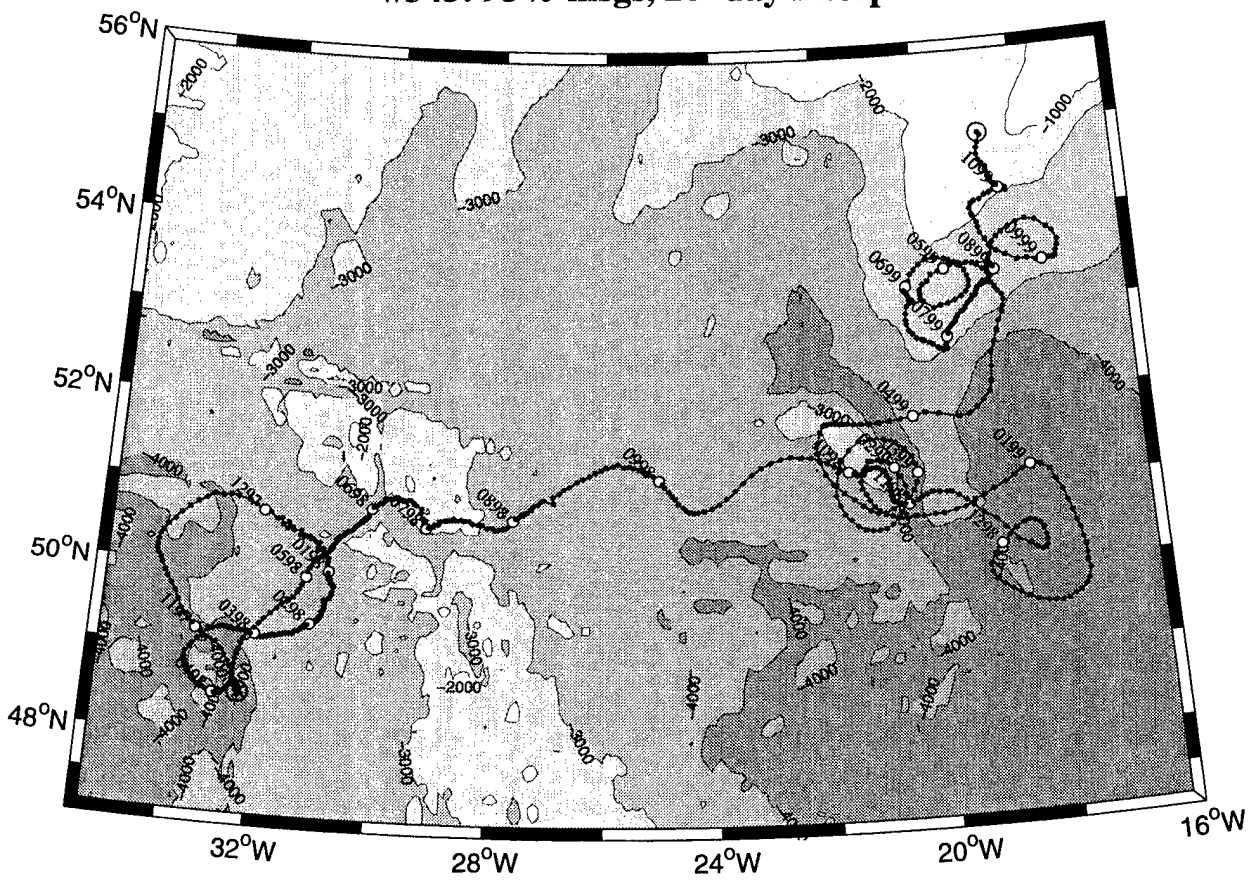

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
9
8
7
6
5
4
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w342: 82% msgs, 20–day interp

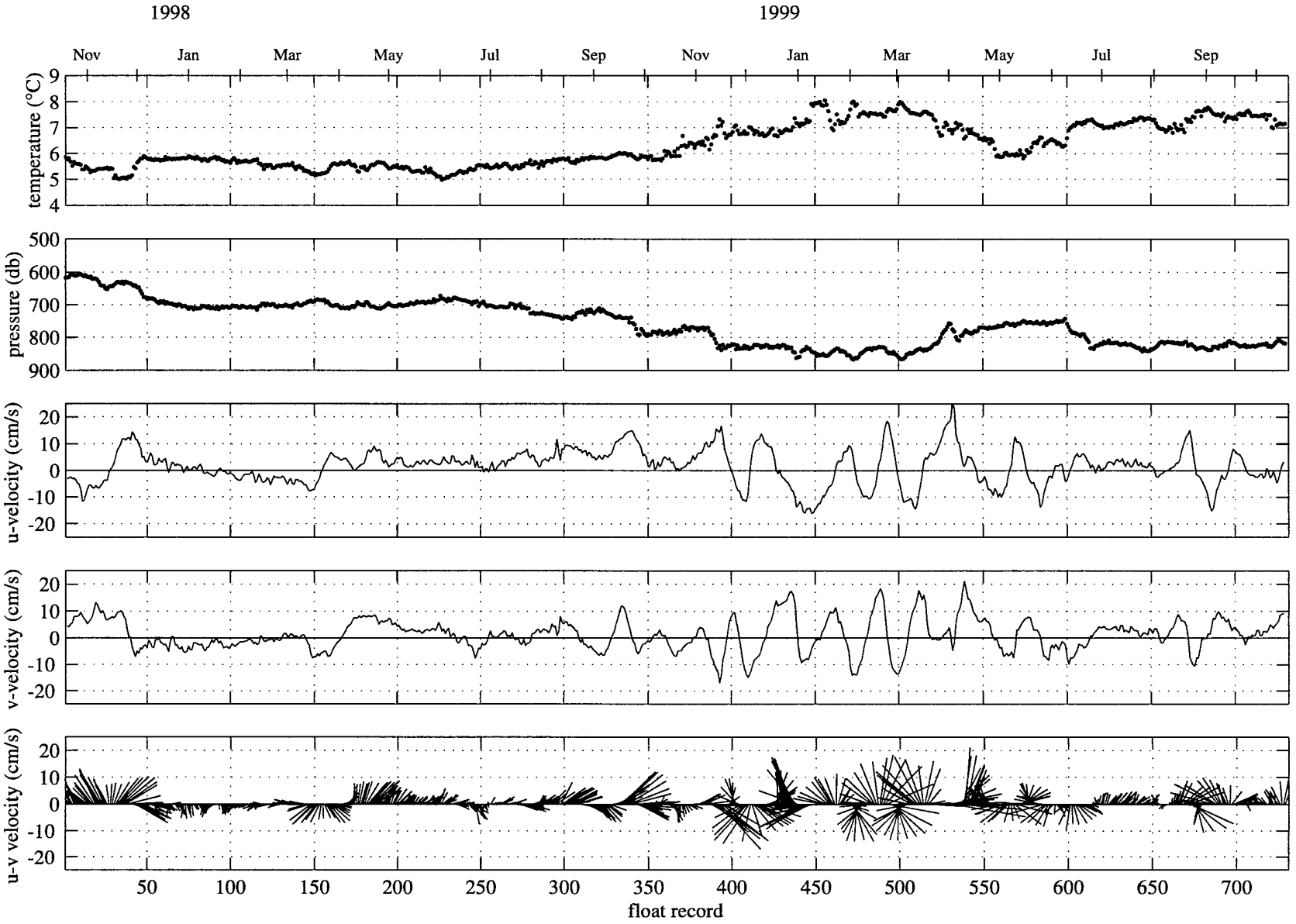


w342

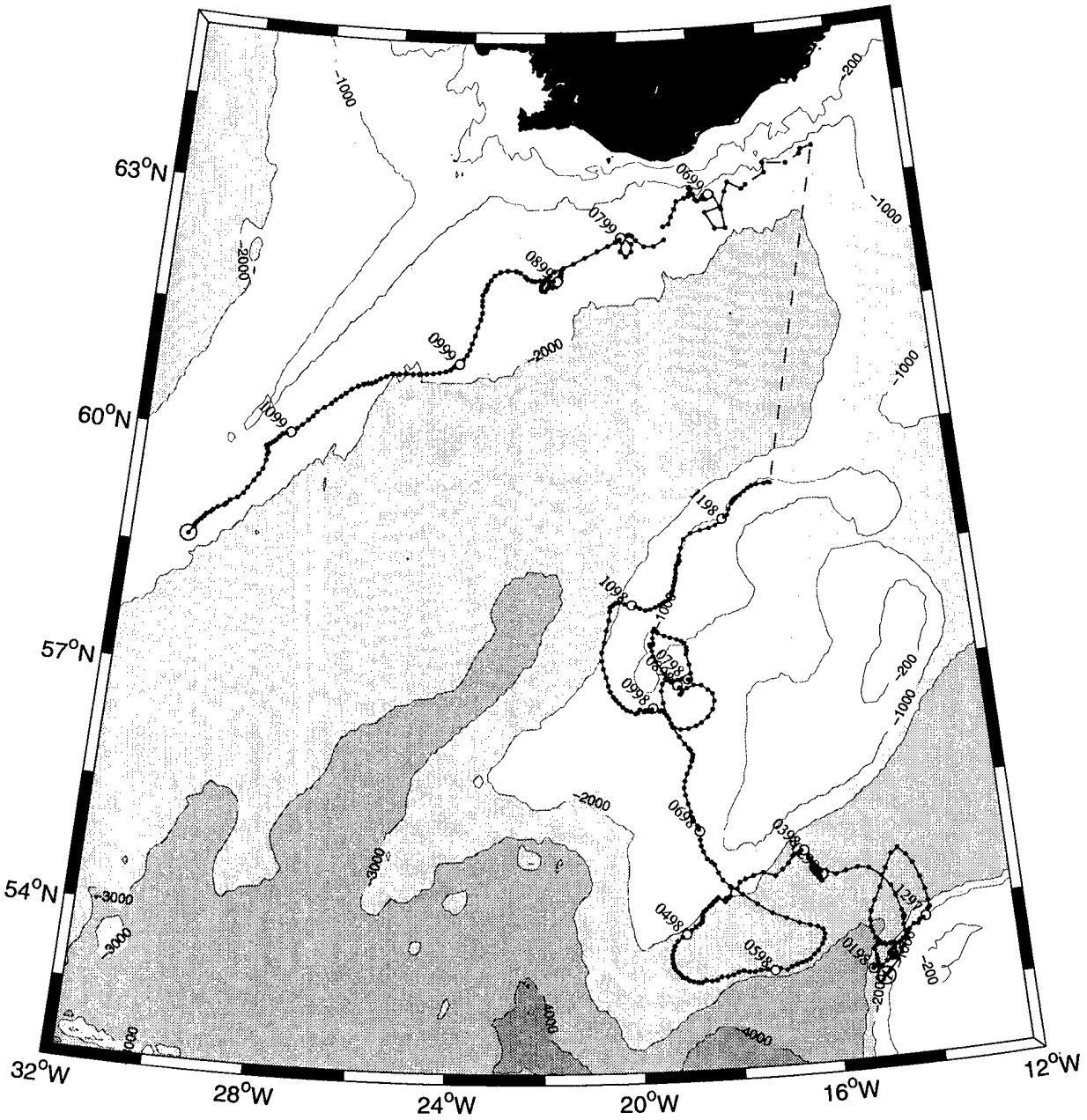

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
10
9
8
7
6
5
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w343: 93% msgs, 20–day interp
56°N
54°N
52°N
50°N
48°N
32°W
28°W
24°W
20°W
16°W

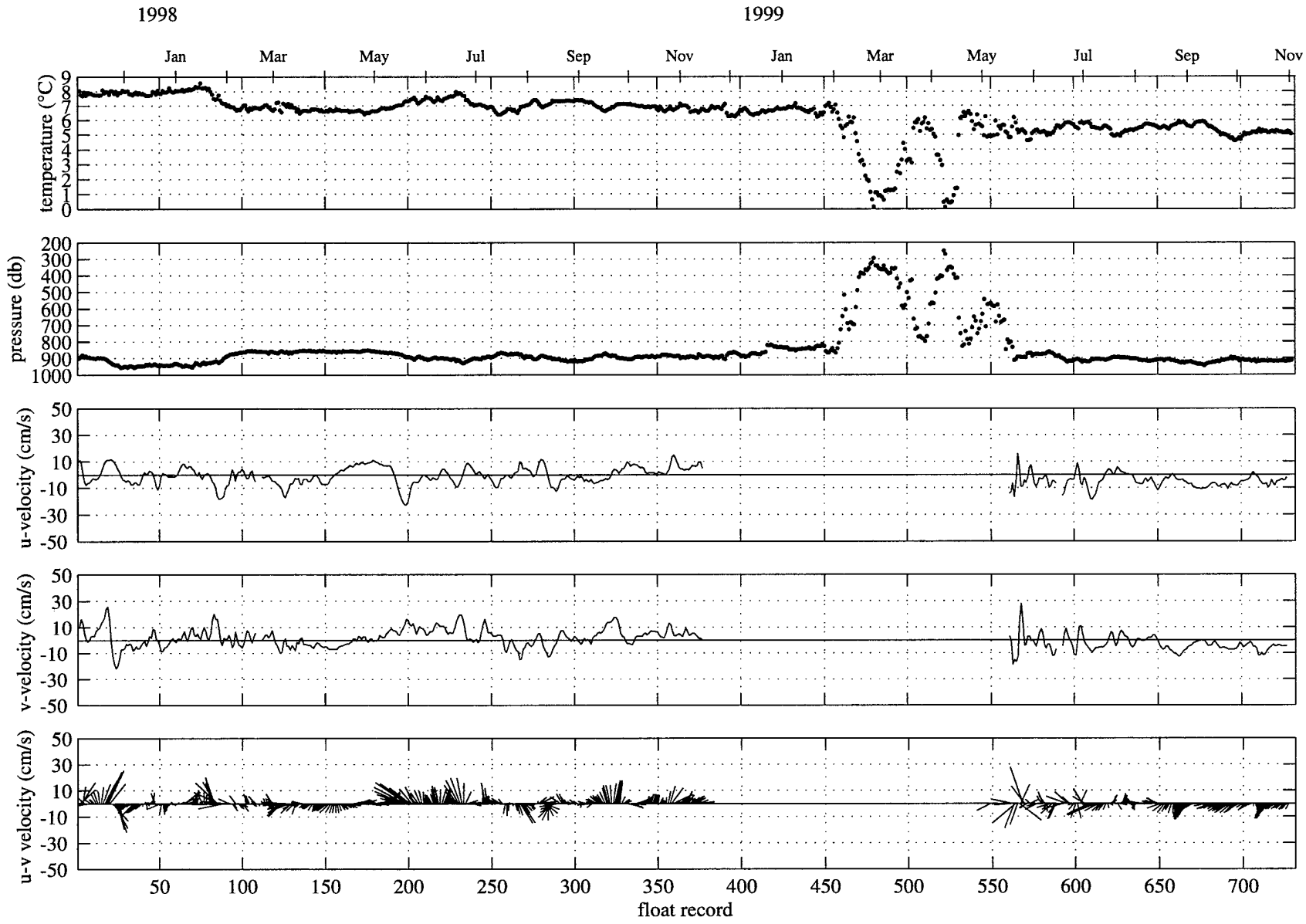
w343


1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
9
8
7
6
5
4
pressure (db)
500
600
700
800
900
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

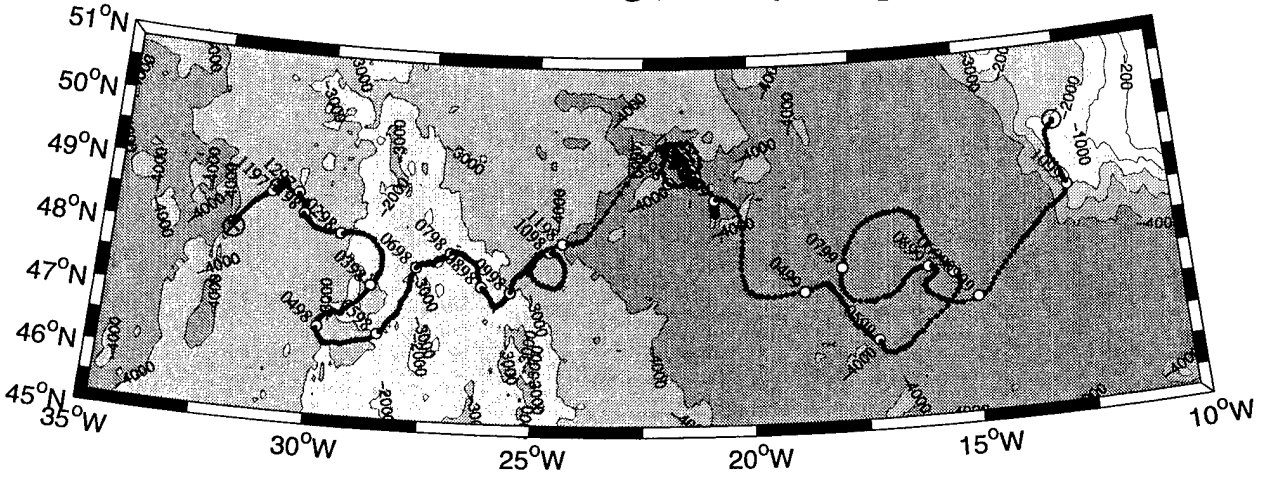
w344: 97% msgs, 20–day interp



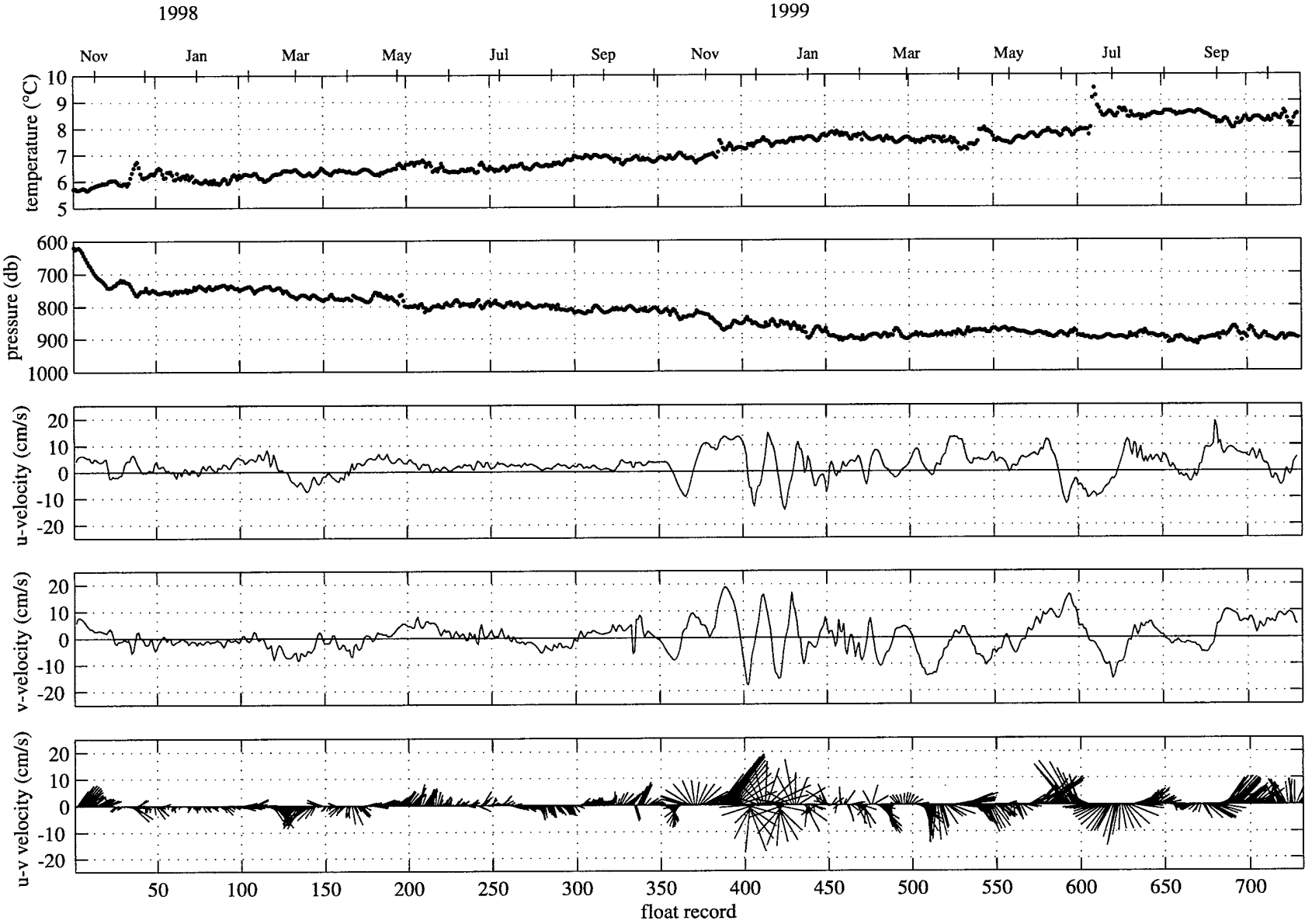
w344


1998
1999
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
pressure (db)
u-velocity (cm/s)
v-velocity (cm/s)
u-v velocity (cm/s)
float record

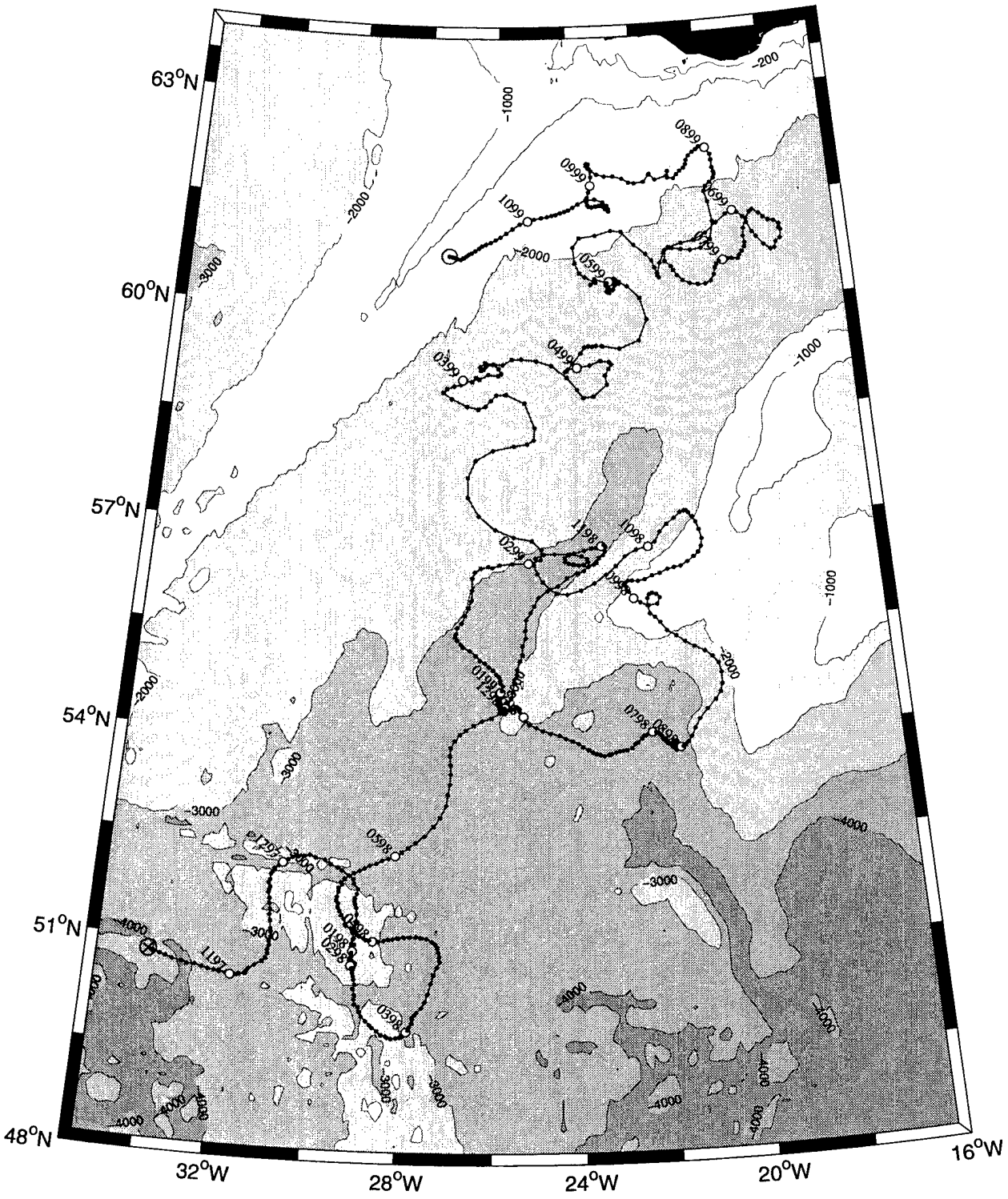
w346: 68% msgs, 20–day interp



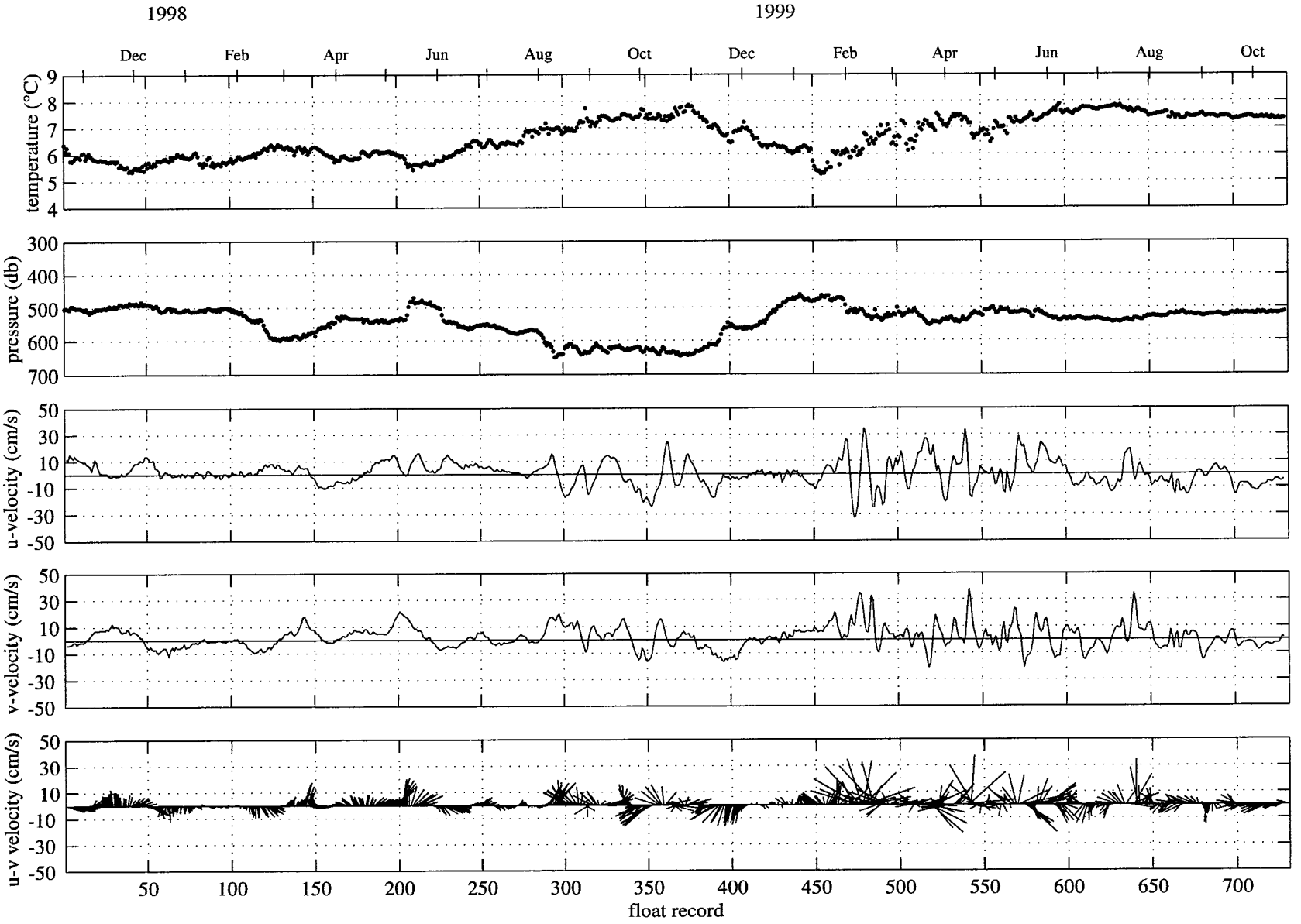
w346


1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
10
9
8
7
6
5
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

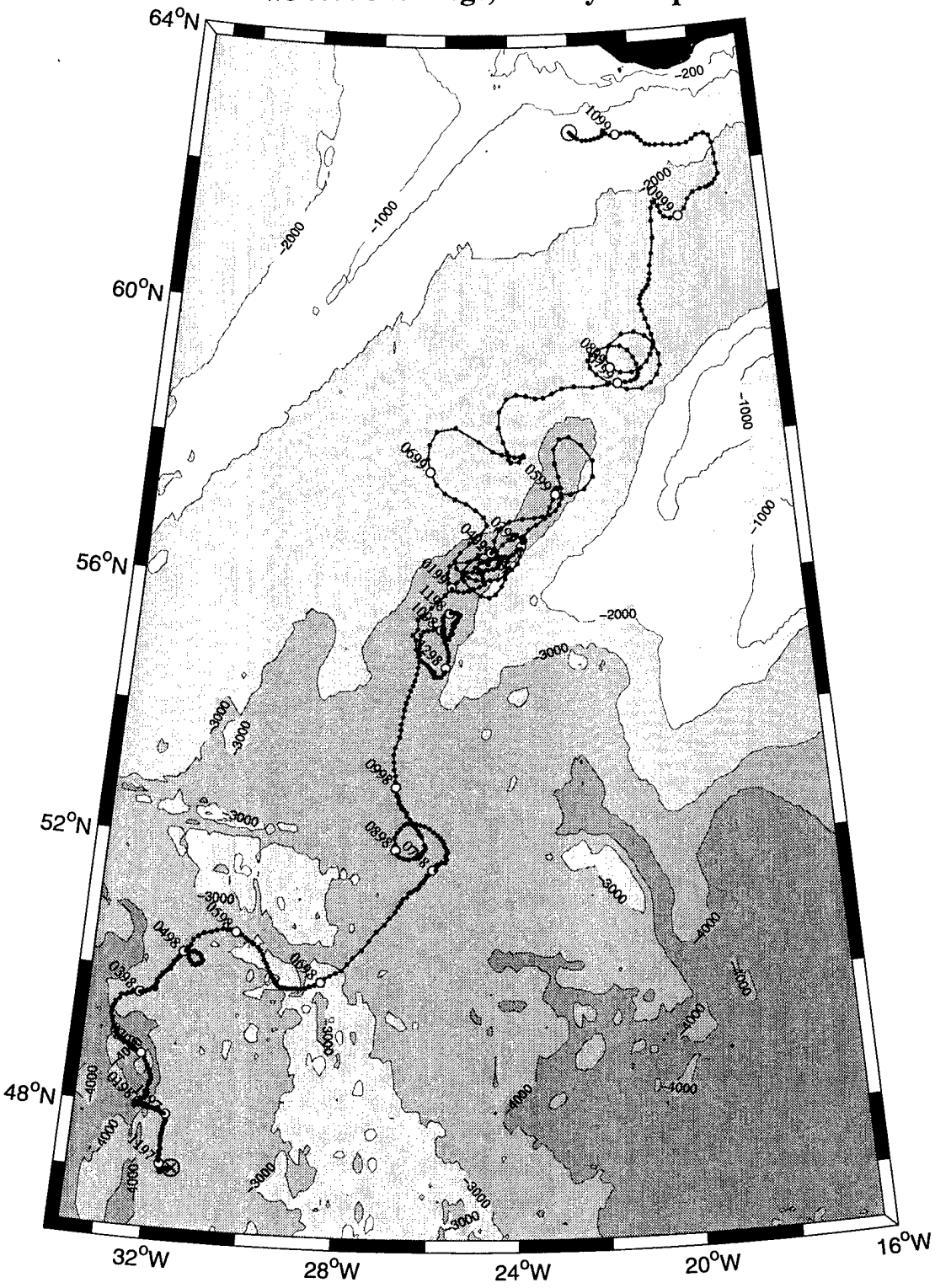
w347: 92% msgs, 10–day interp



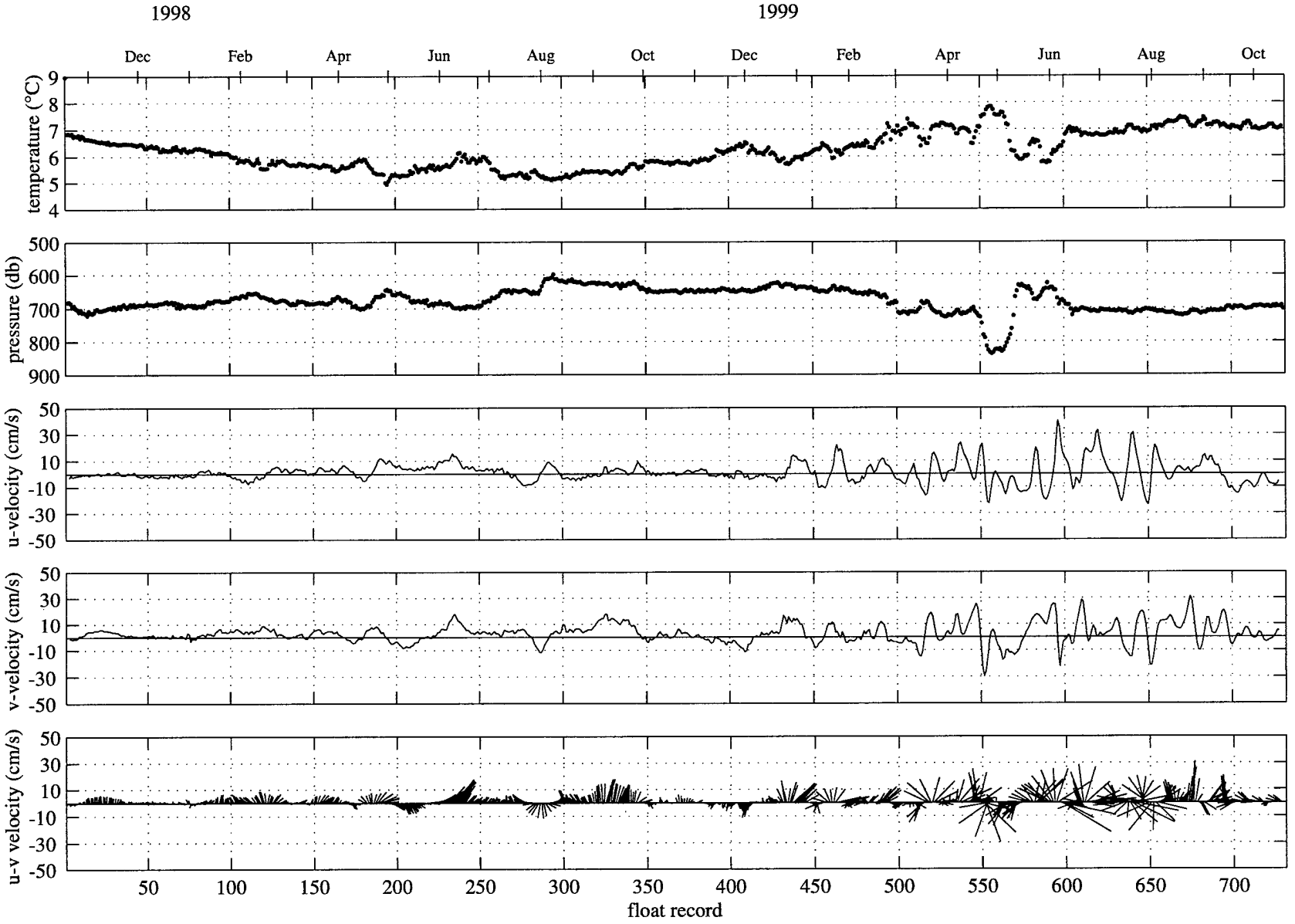
w347

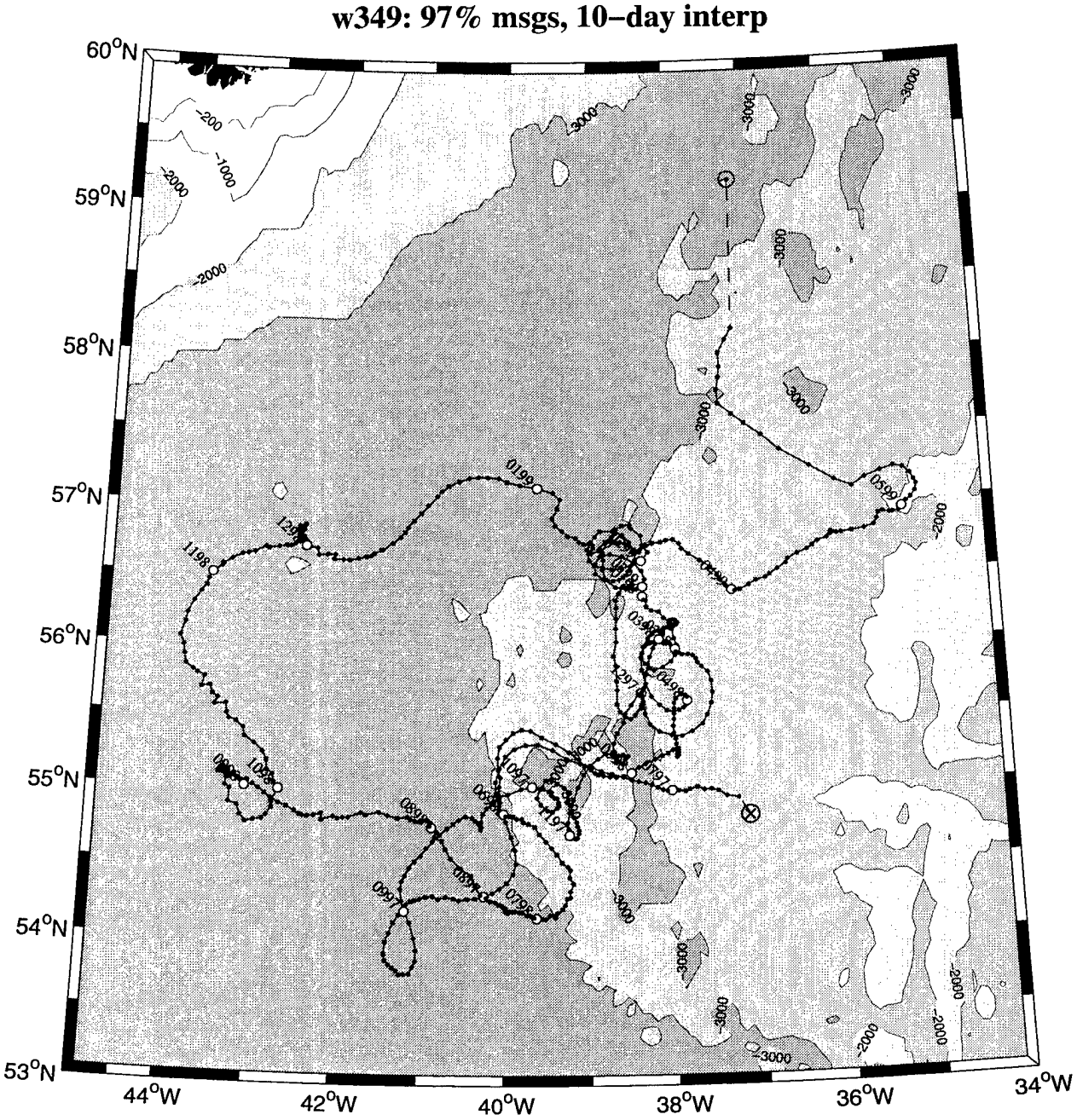

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
9
8
7
6
5
4
pressure (db)
300
400
500
600
700
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w348: 93% msgs, 10–day interp

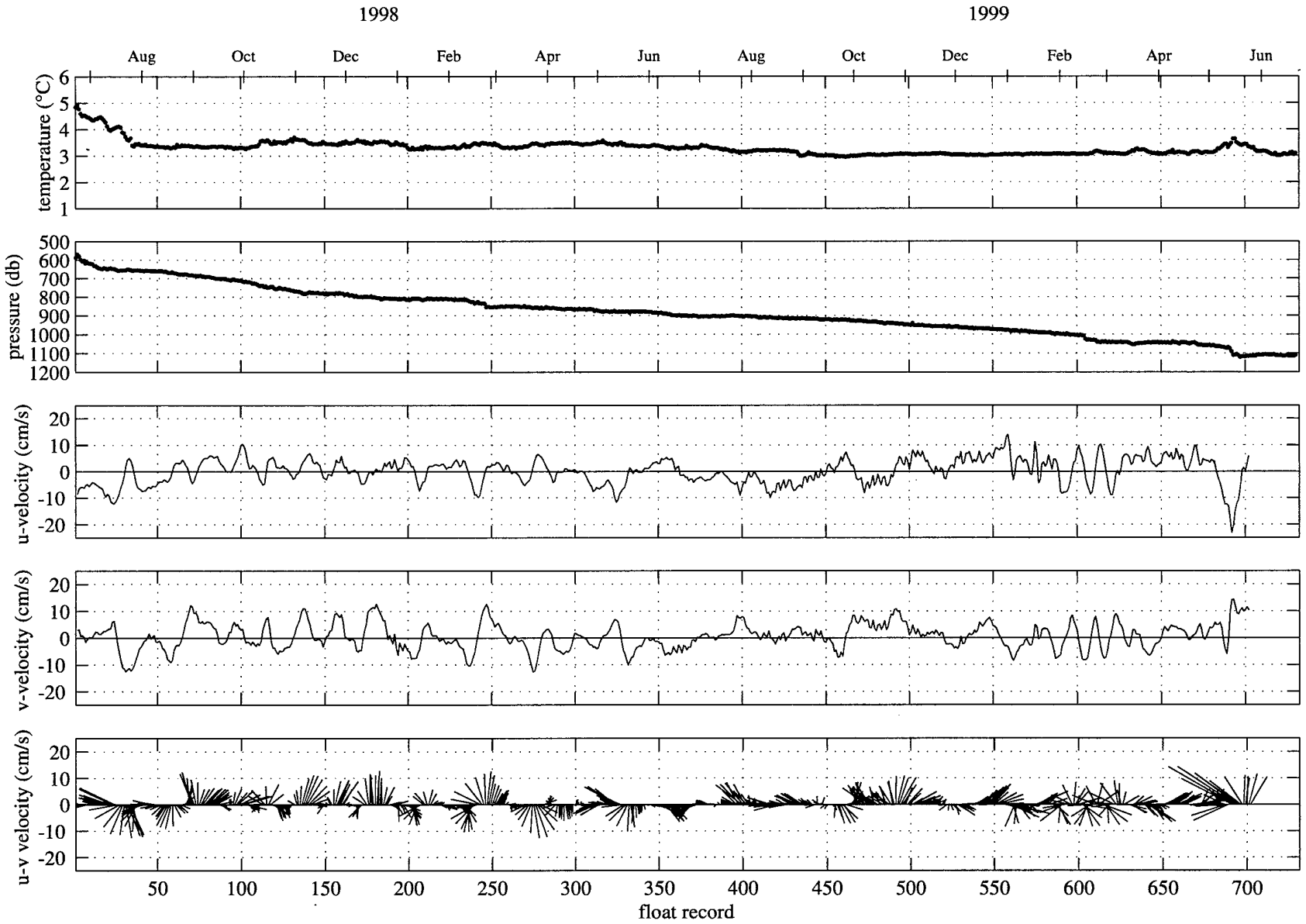


w348

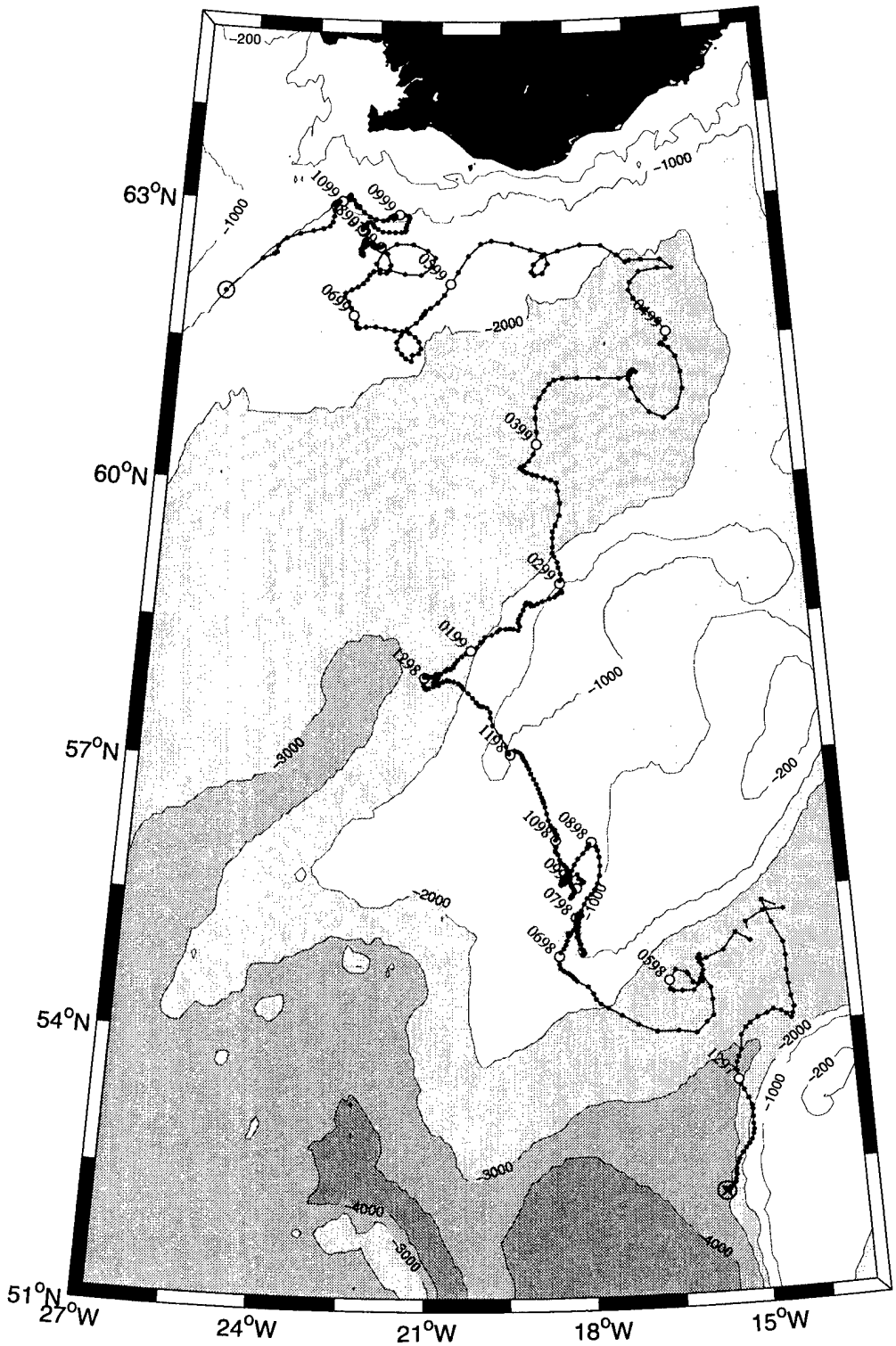

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
9
8
7
6
5
4
pressure (db)
500
600
700
800
900
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w349: 97% msgs, 10–day interp
60°N
59°N
58°N
57°N
56°N
55°N
54°N
53°N
44°W
42°W
40°W
38°W
36°W
34°W

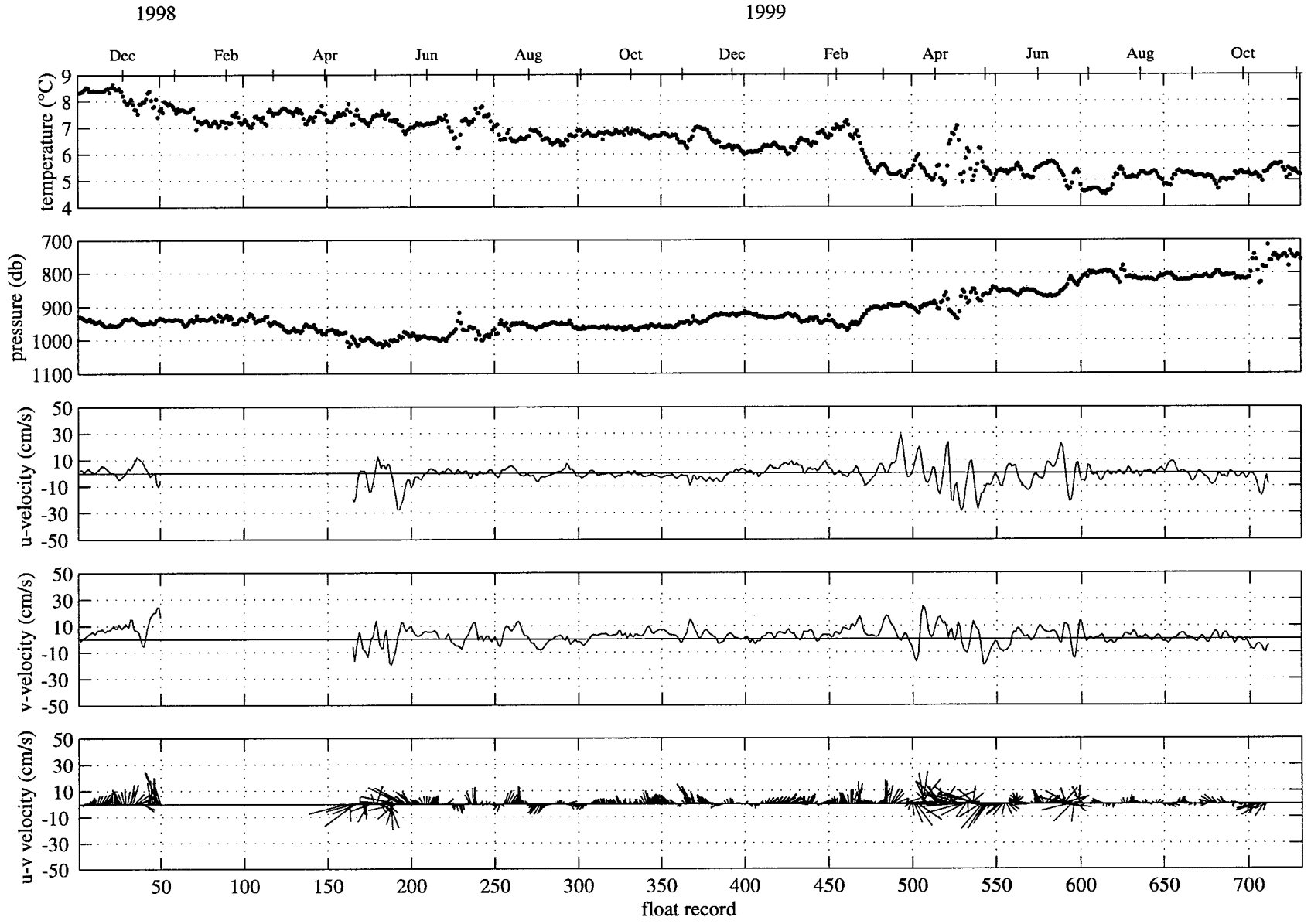
w349


1998
1999
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
temperature (°C)
pressure (db)
u-velocity (cm/s)
v-velocity (cm/s)
u-v velocity (cm/s)
float record

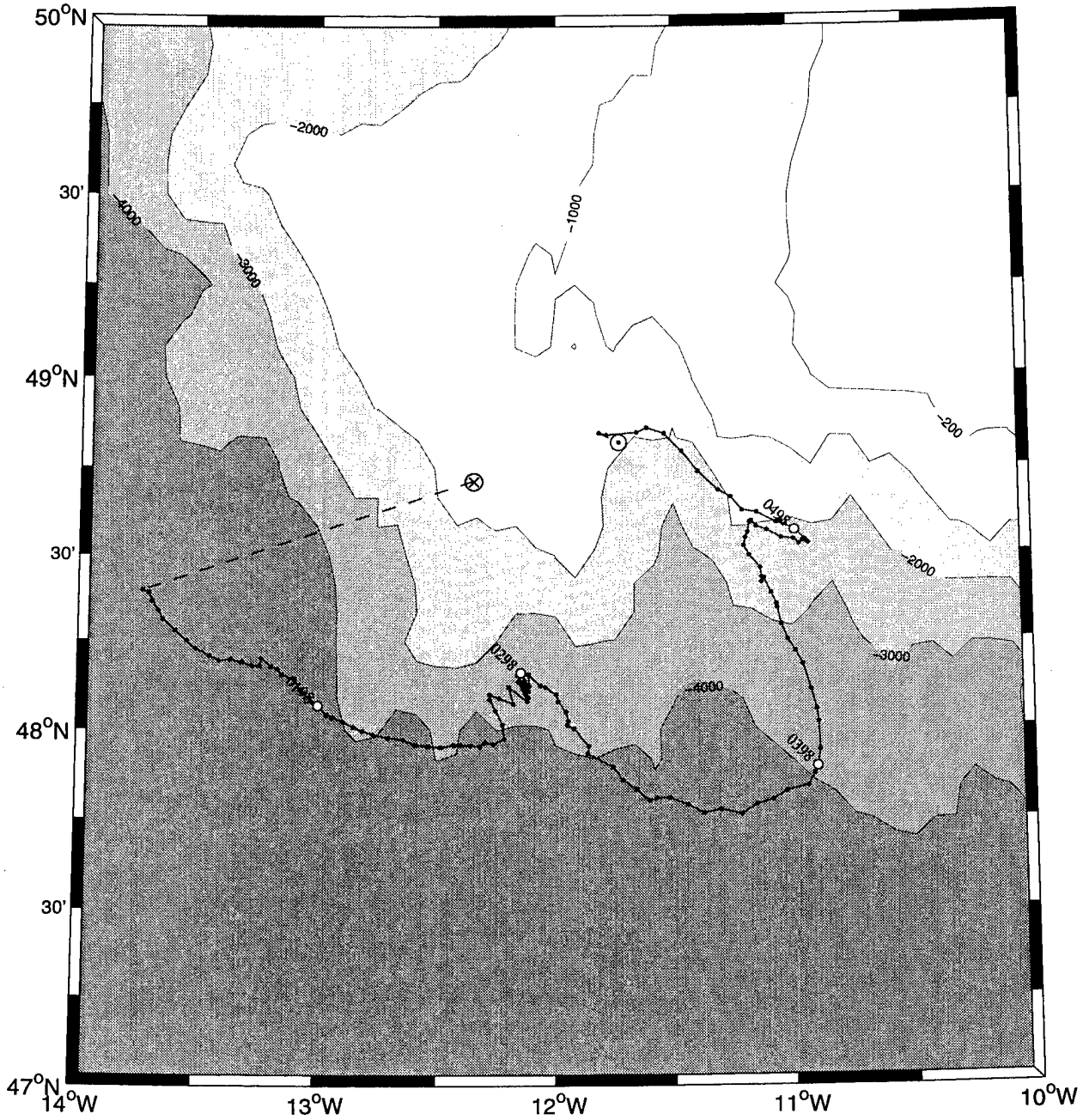
w350: 92% msgs, 20–day interp



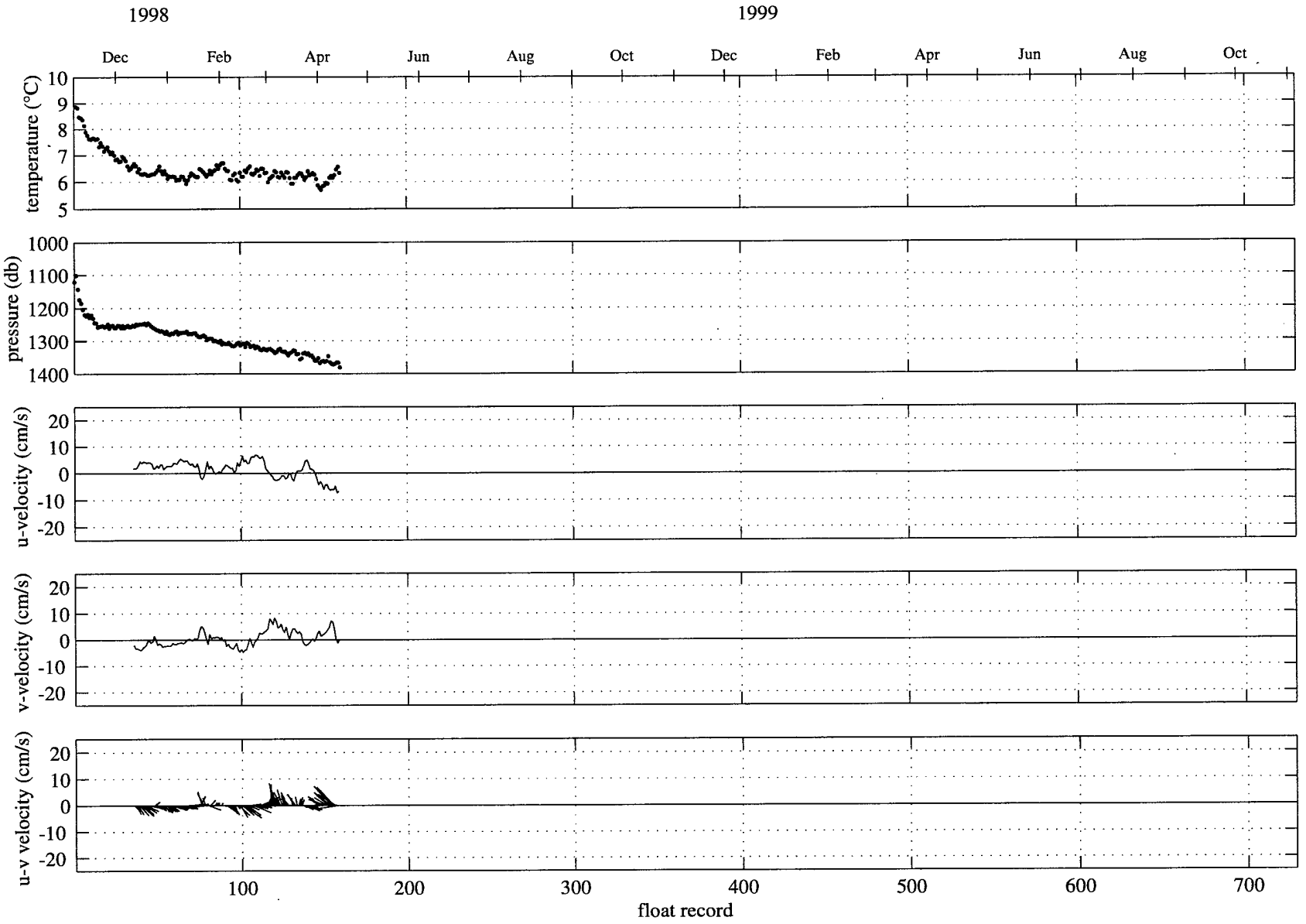
w350


1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
9
8
7
6
5
4
pressure (db)
700
800
900
1000
1100
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

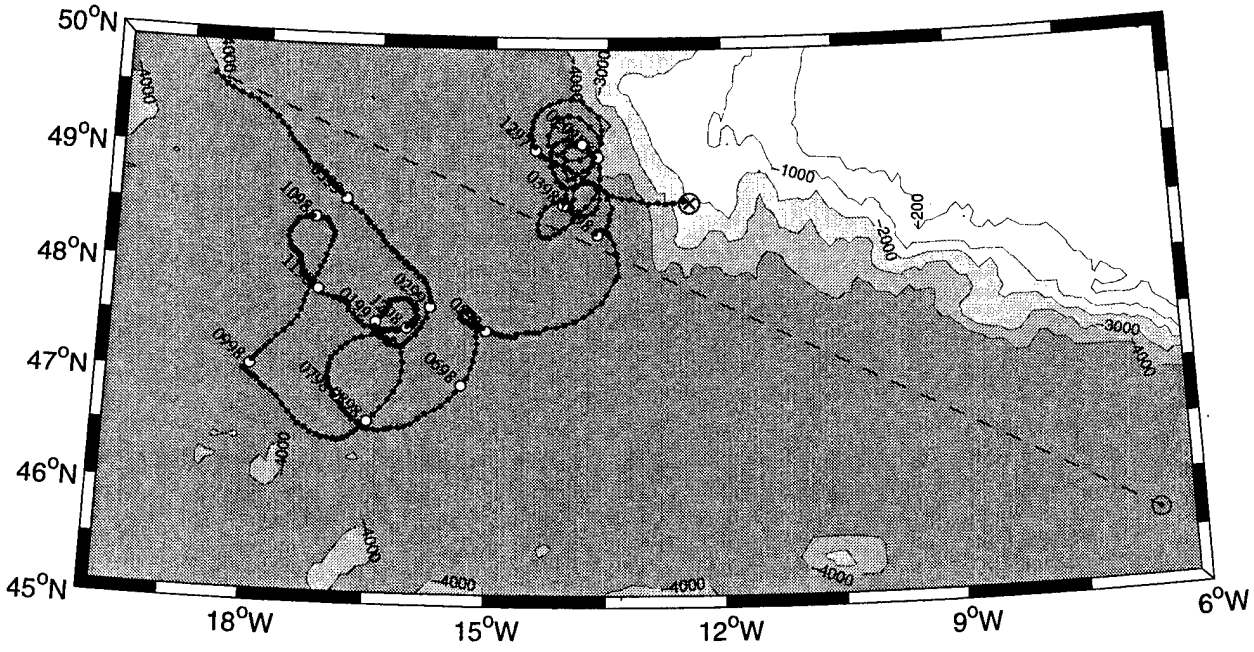
w351: 81% msgs, 20–day interp



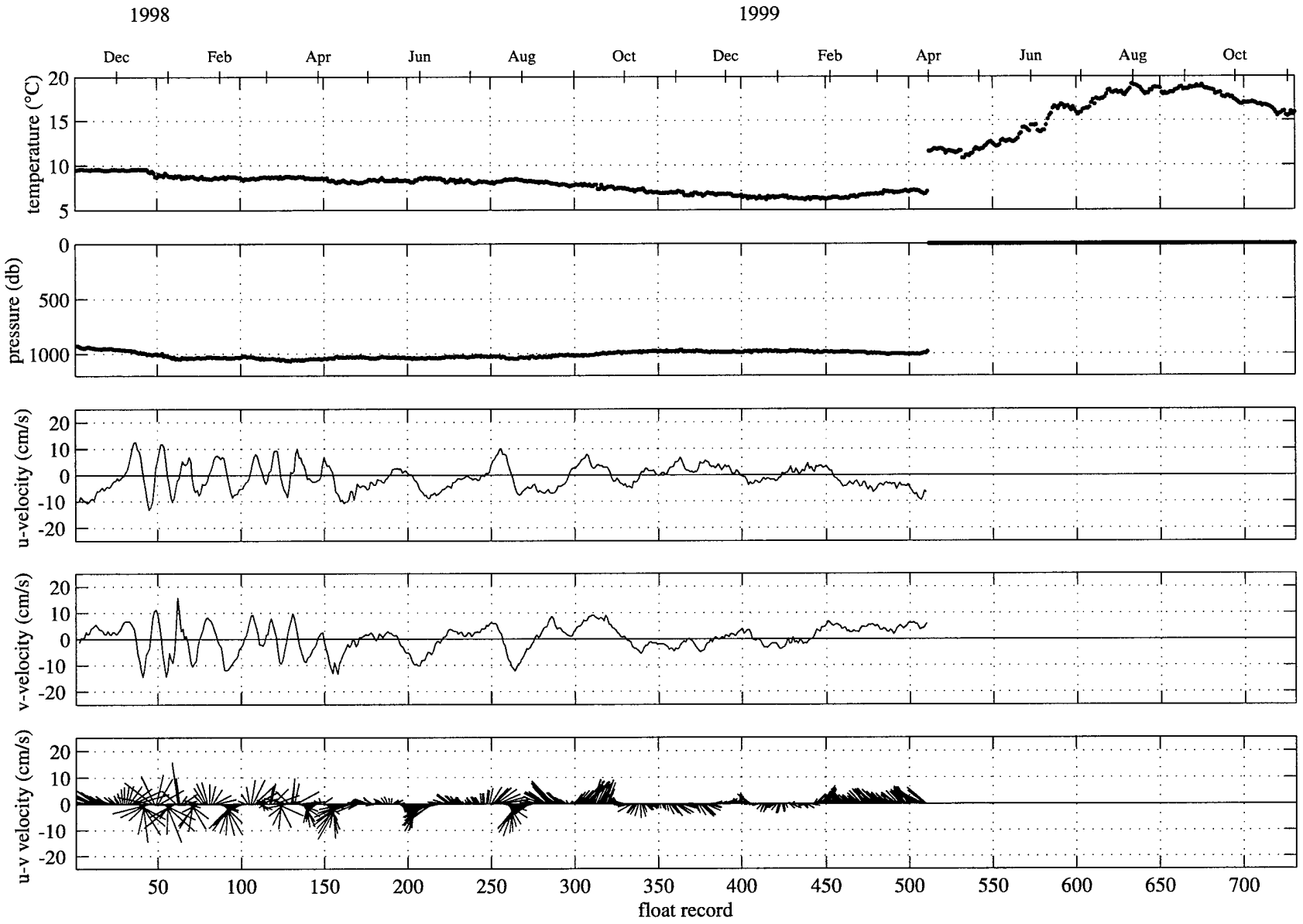
w351

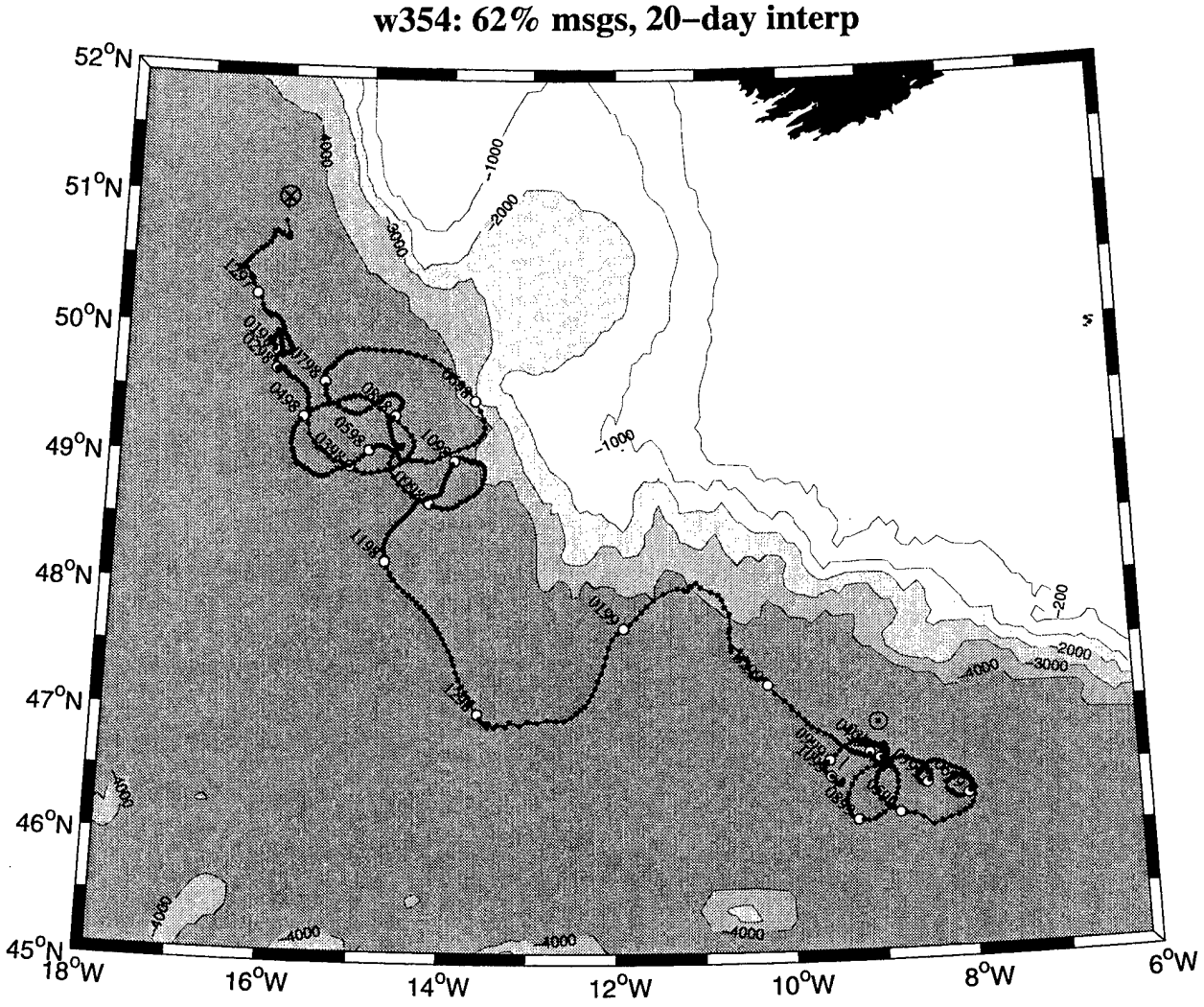

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
10
9
8
7
6
5
pressure (db)
1000
1100
1200
1300
1400
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
100
200
300
400
500
600
700
float record

w352: 100% msgs, 10–day interp

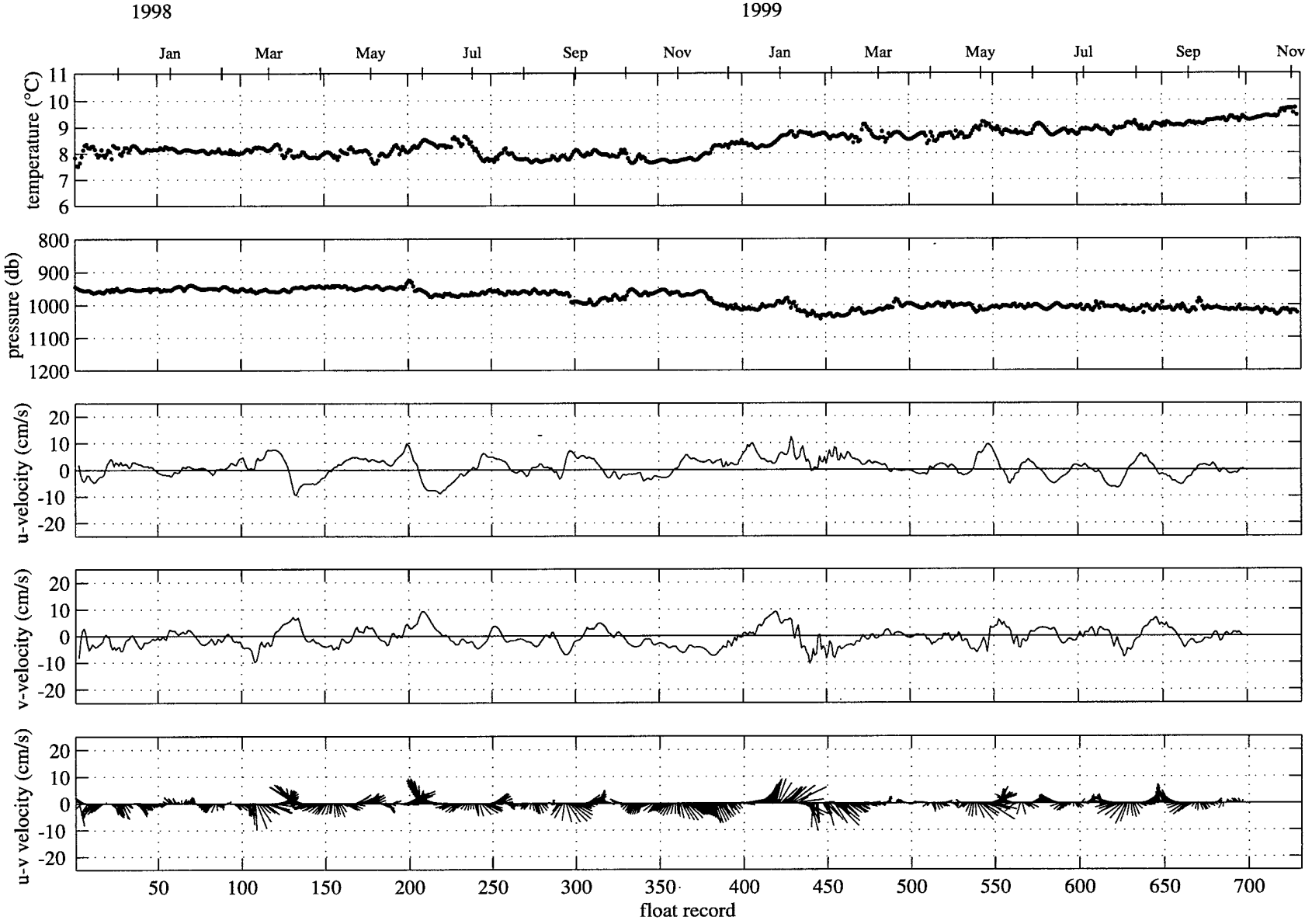


w352

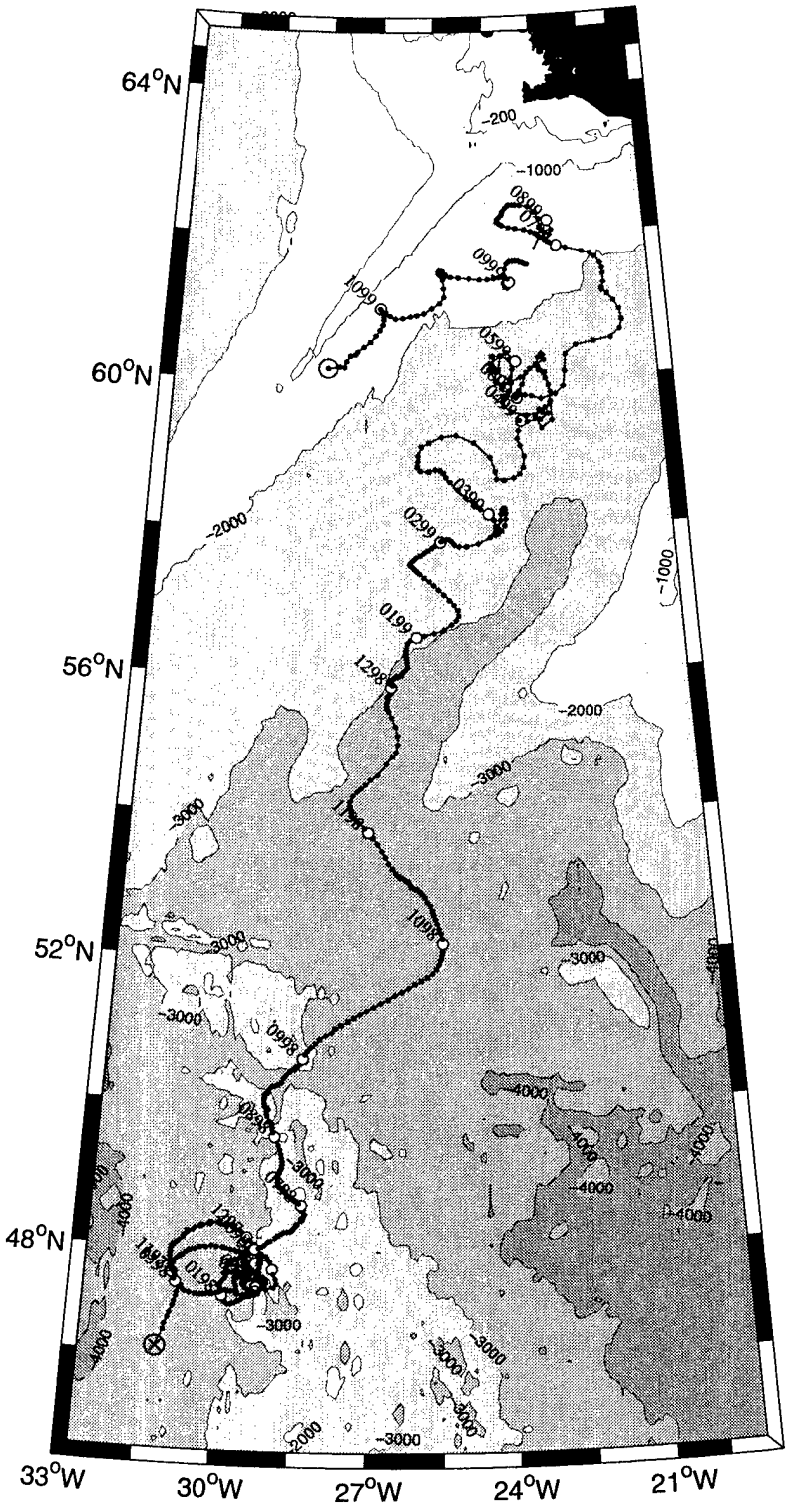

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
20
15
10
5
pressure (db)
0
500
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w354: 62% msgs, 20–day interp
52°N
51°N
50°N
49°N
48°N
47°N
46°N
45°N
18°W
16°W
14°W
12°W
10°W
8°W
6°W
-1000
-2000
-3000
-4000
-200

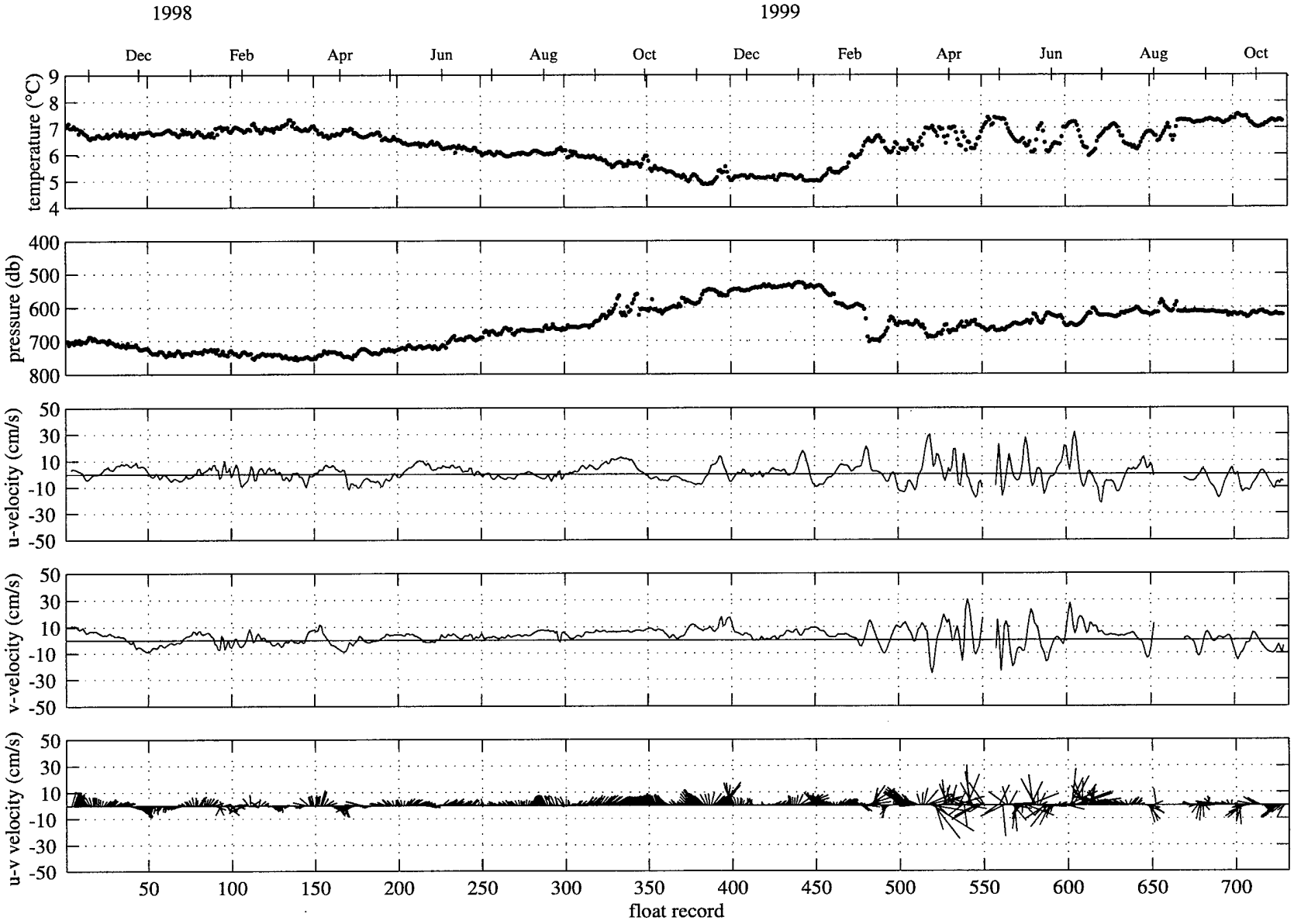
w354


1998
1999
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
11
10
9
8
7
6
pressure (db)
800
900
1000
1100
1200
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

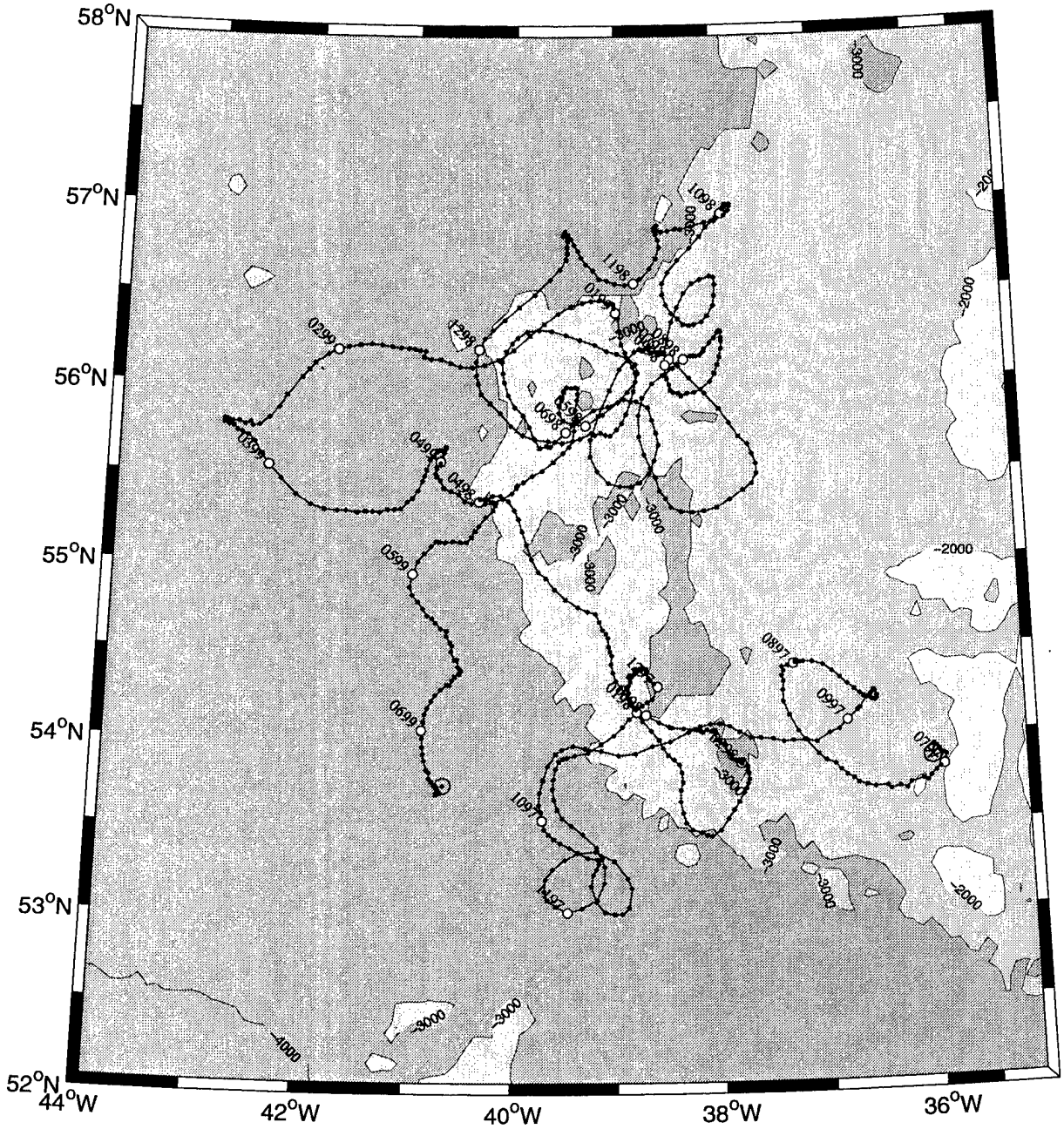
w355: 90% msgs, 20–day interp



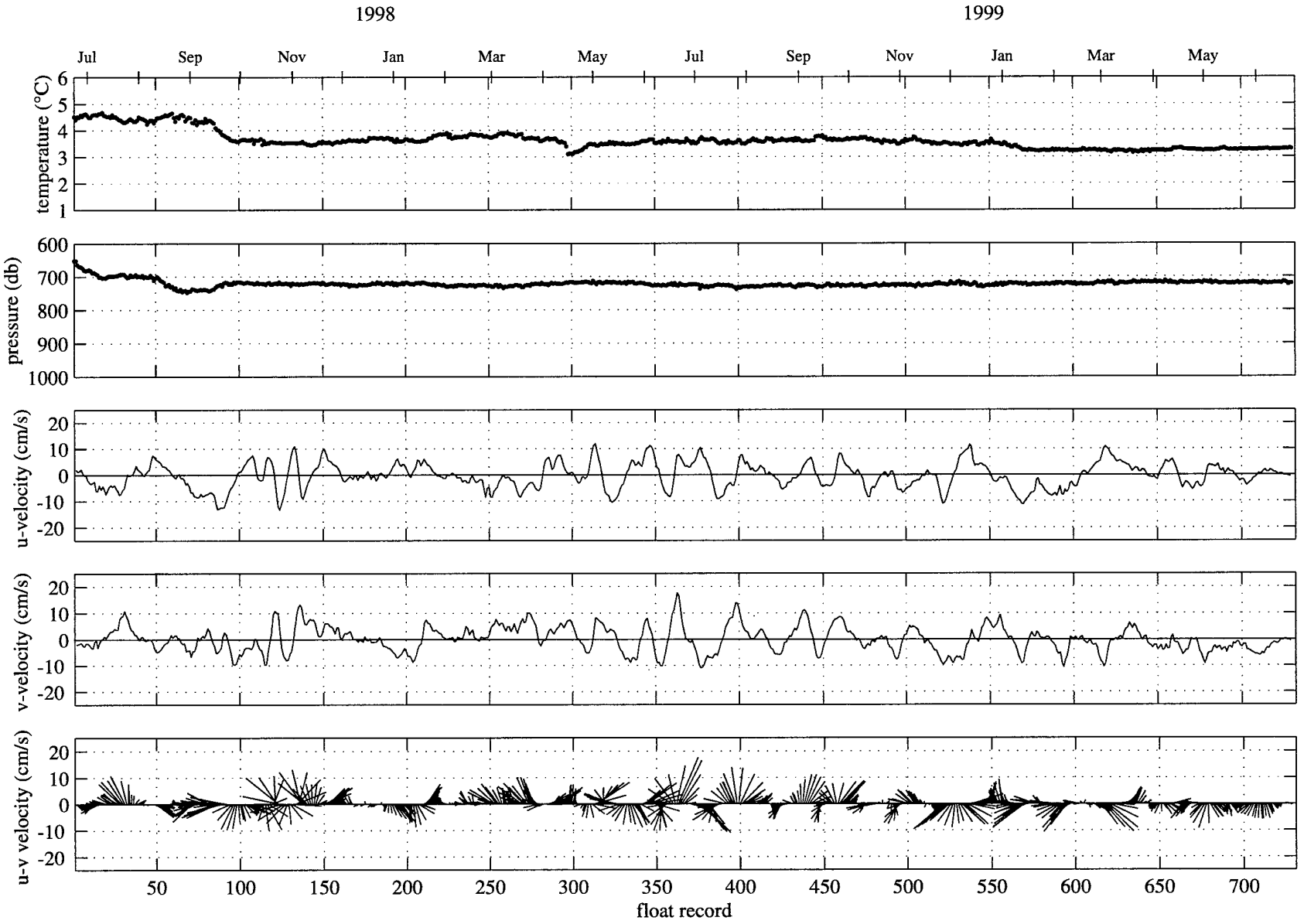
w355

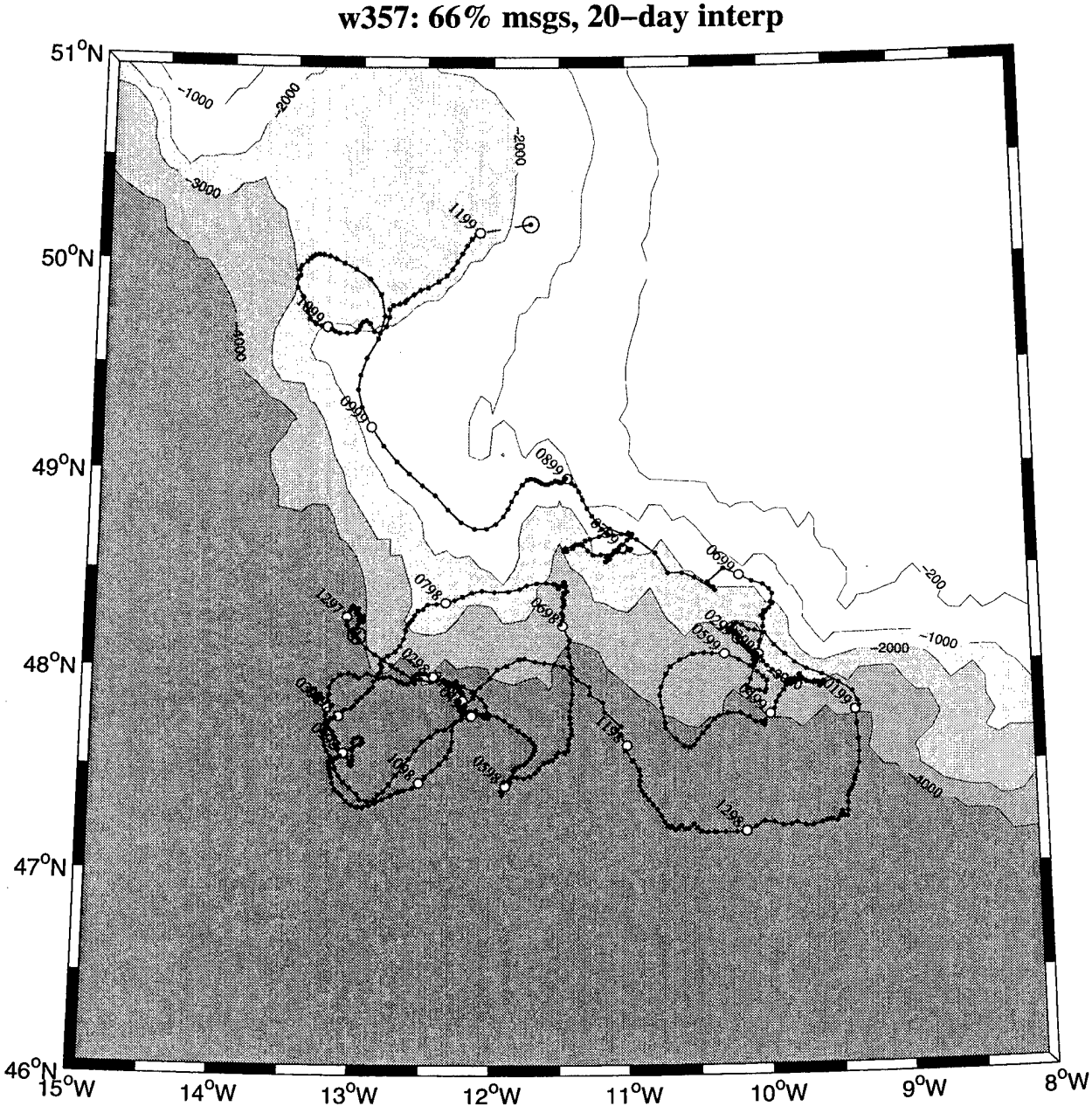

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
9
8
7
6
5
4
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
v-velocity (cm/s)
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w356: 99% msgs, 10–day interp

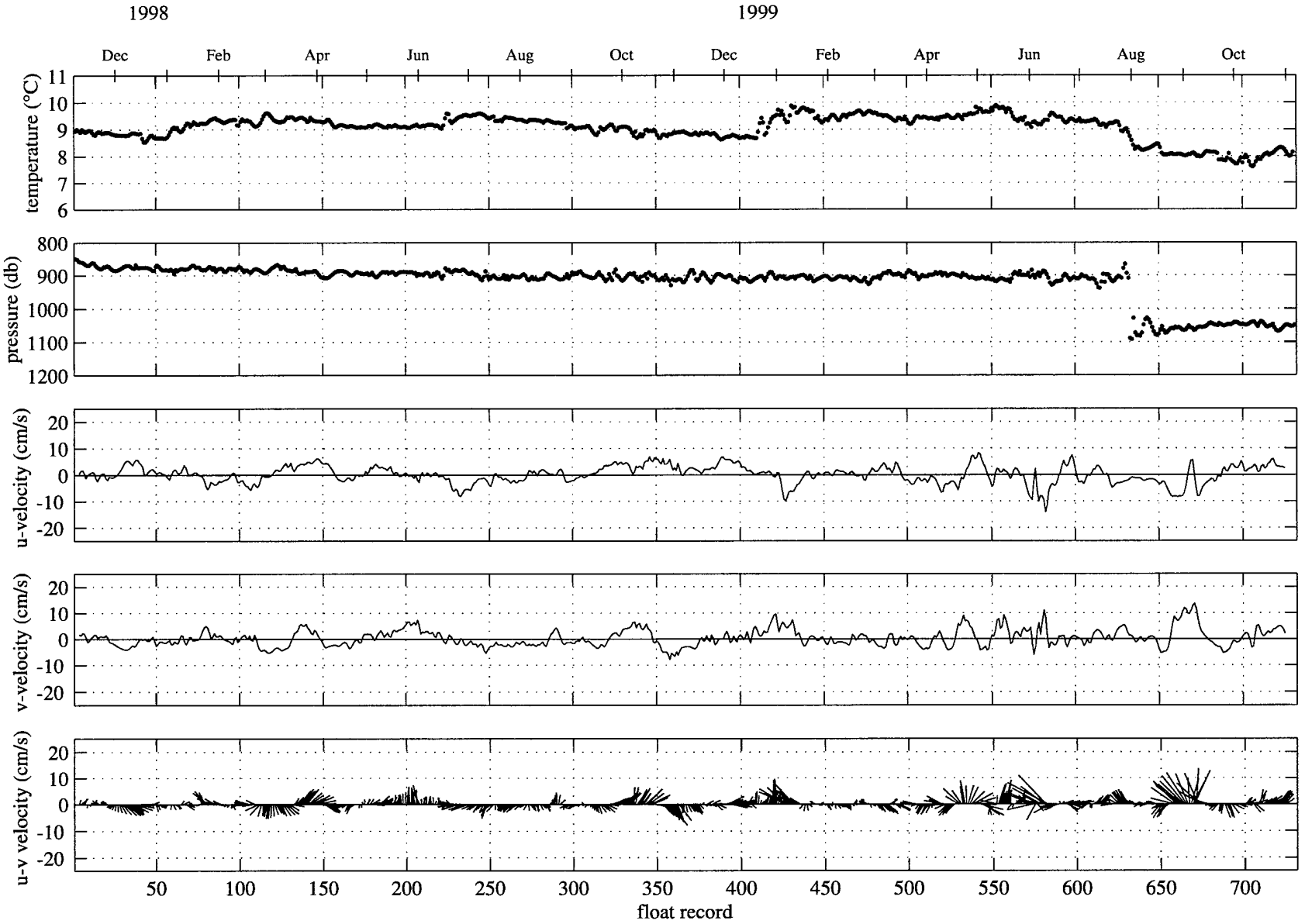


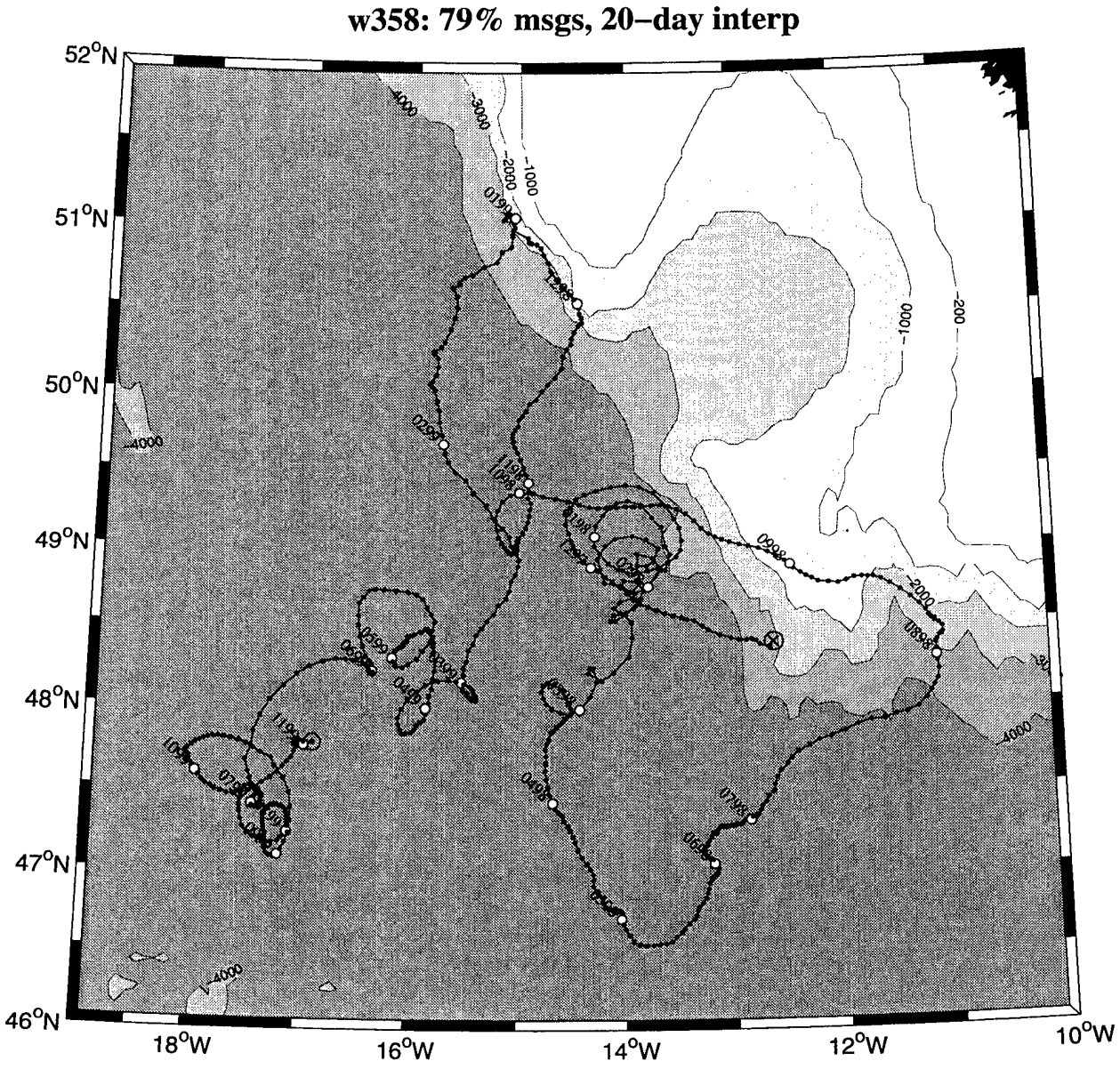
w356


1998
1999
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
temperature (°C)
pressure (db)
u-velocity (cm/s)
v-velocity (cm/s)
u-v velocity (cm/s)
float record

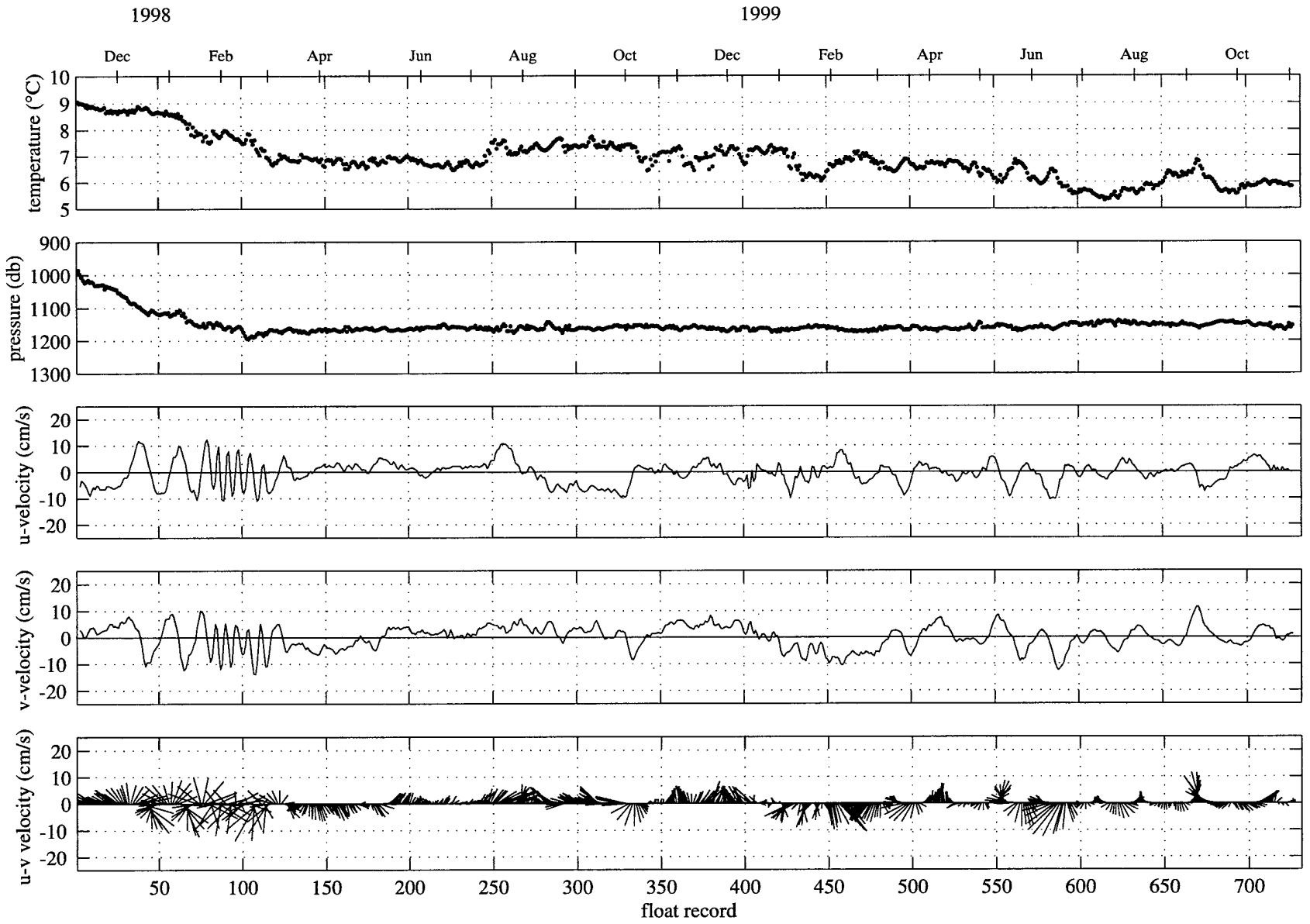

w357: 66% msgs, 20–day interp
51°N
50°N
49°N
48°N
47°N
46°N
15°W
14°W
13°W
12°W
11°W
10°W
9°W
8°W
-1000
-2000
-3000
-4000
-200

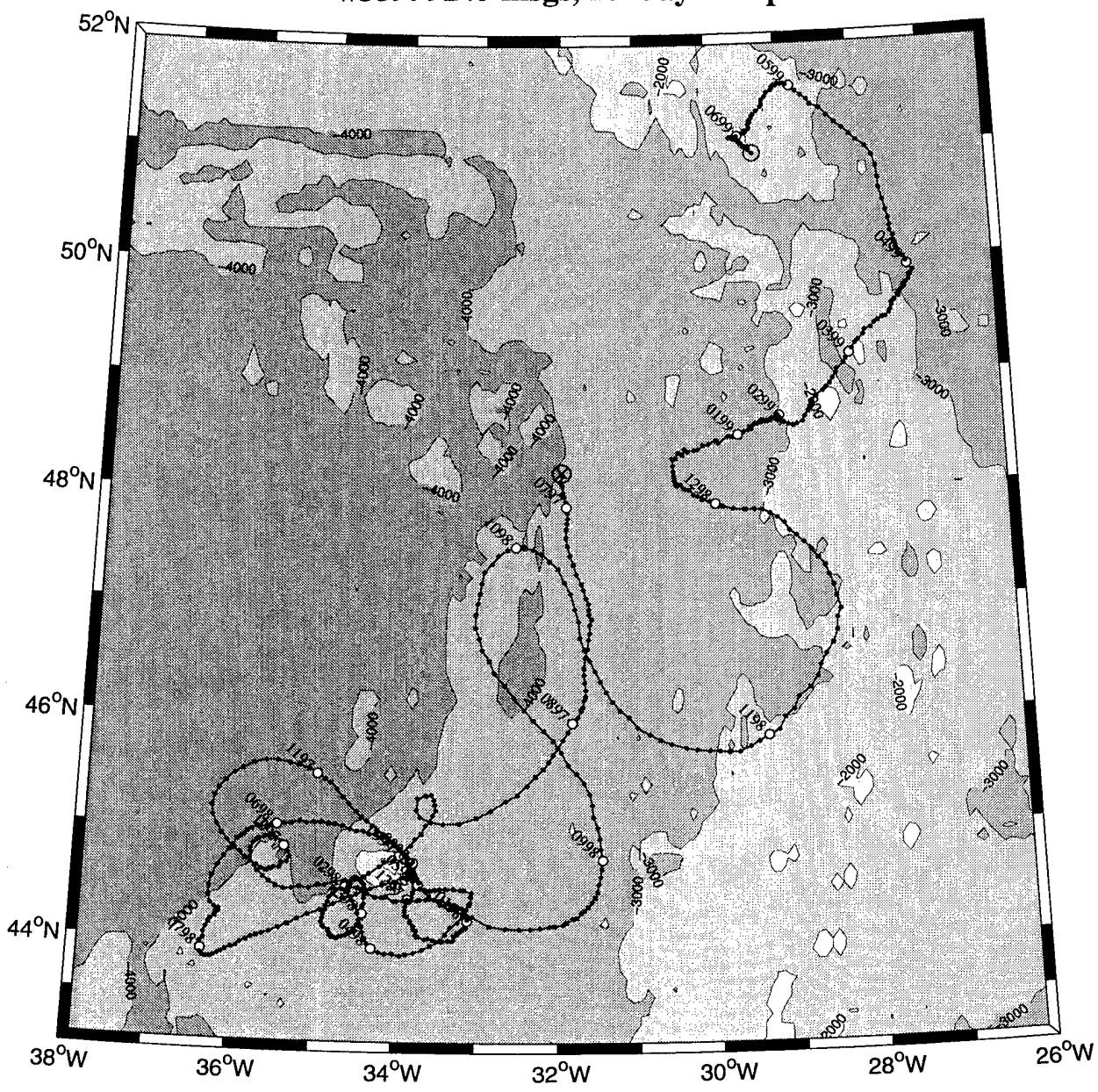
w357


1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
11
10
9
8
7
6
pressure (db)
800
900
1000
1100
1200
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

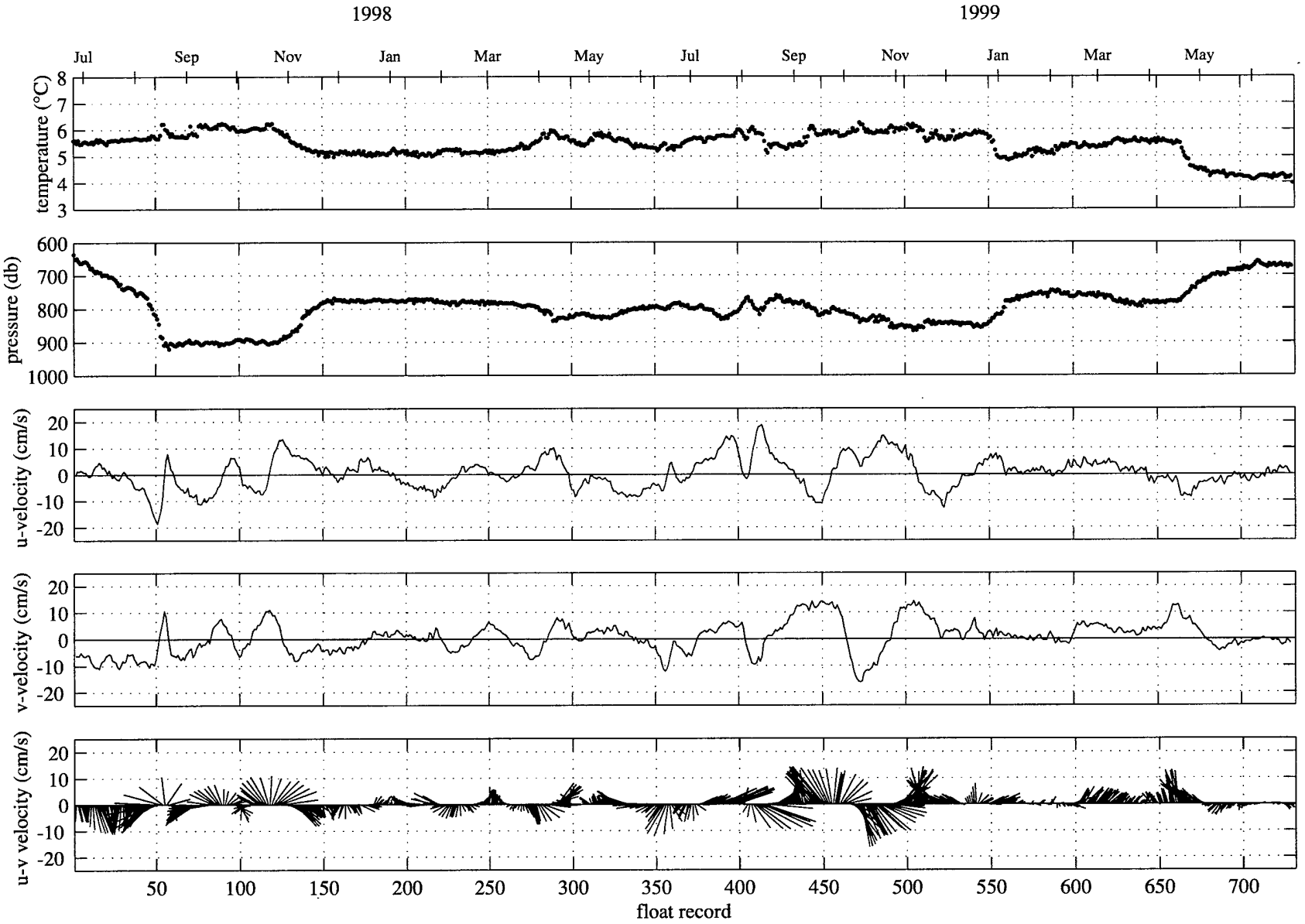

w358: 79% msgs, 20-day interp
52°N
51°N
50°N
49°N
48°N
47°N
46°N
18°W
16°W
14°W
12°W
10°W
-4000
-3000
-2000
-1000
-200

w358

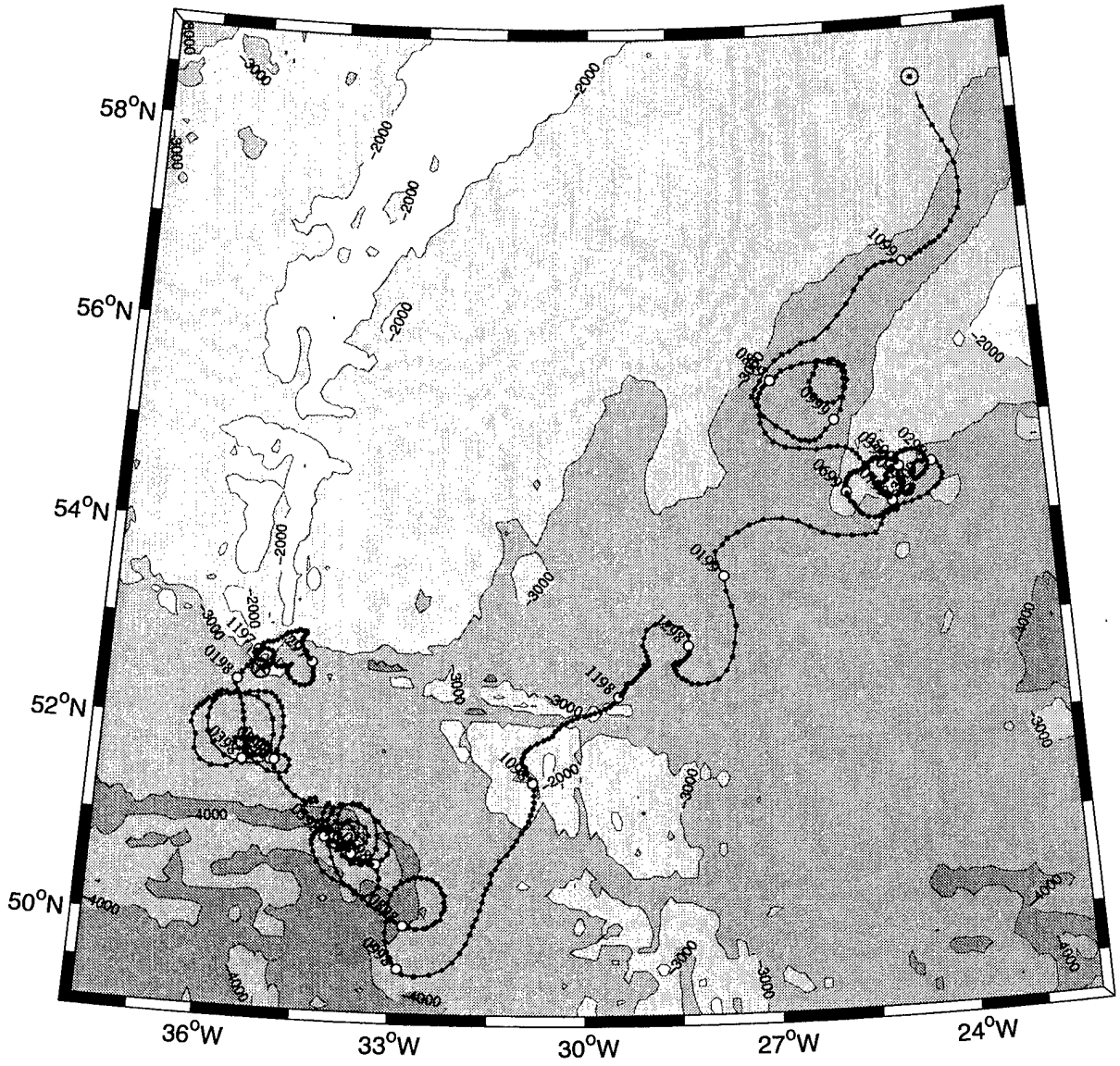

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
10
9
8
7
6
5
pressure (db)
900
1000
1100
1200
1300
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w359: 92% msgs, 10–day interp
52°N
50°N
48°N
46°N
44°N
38°W
36°W
34°W
32°W
30°W
28°W
26°W

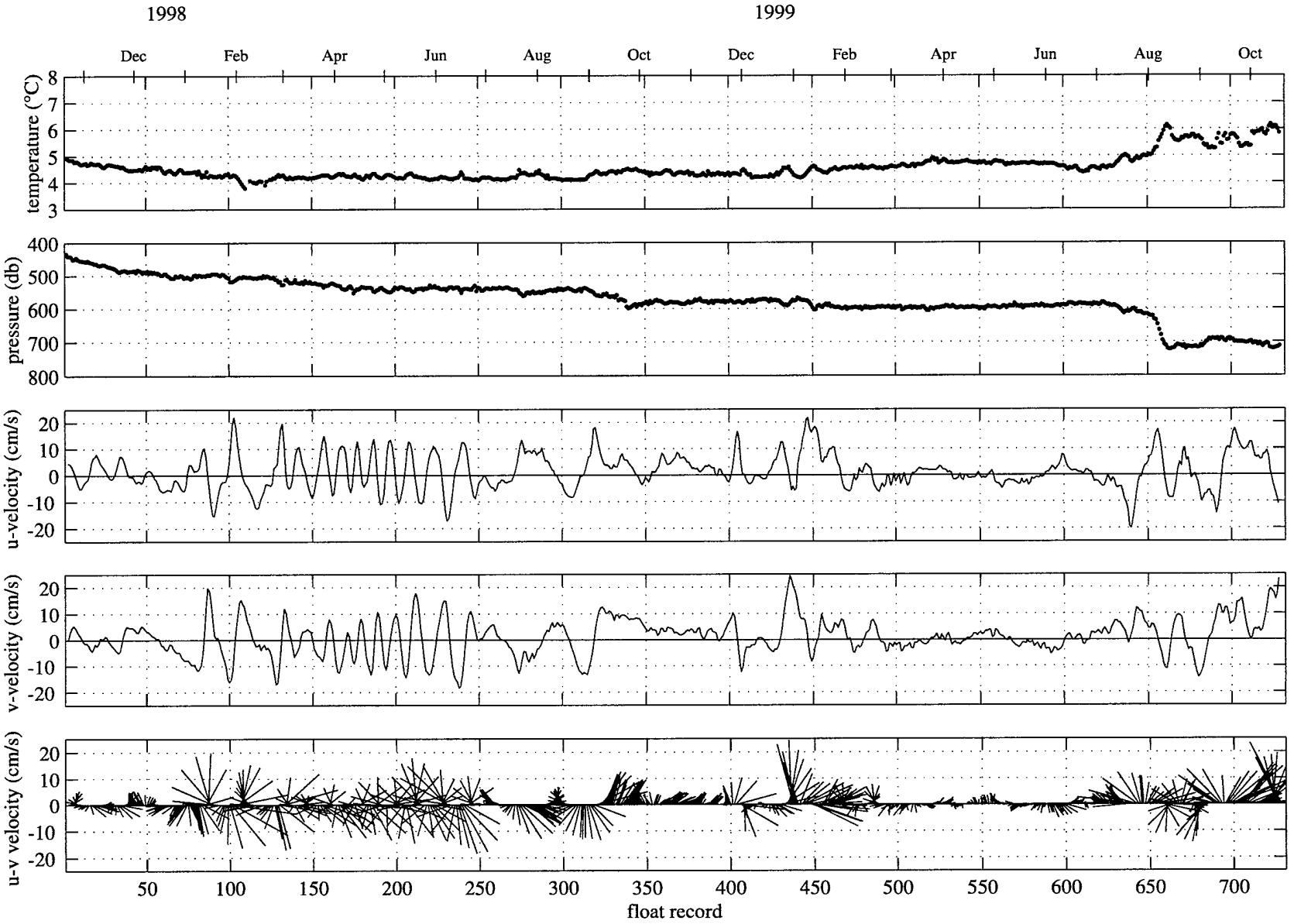
w359

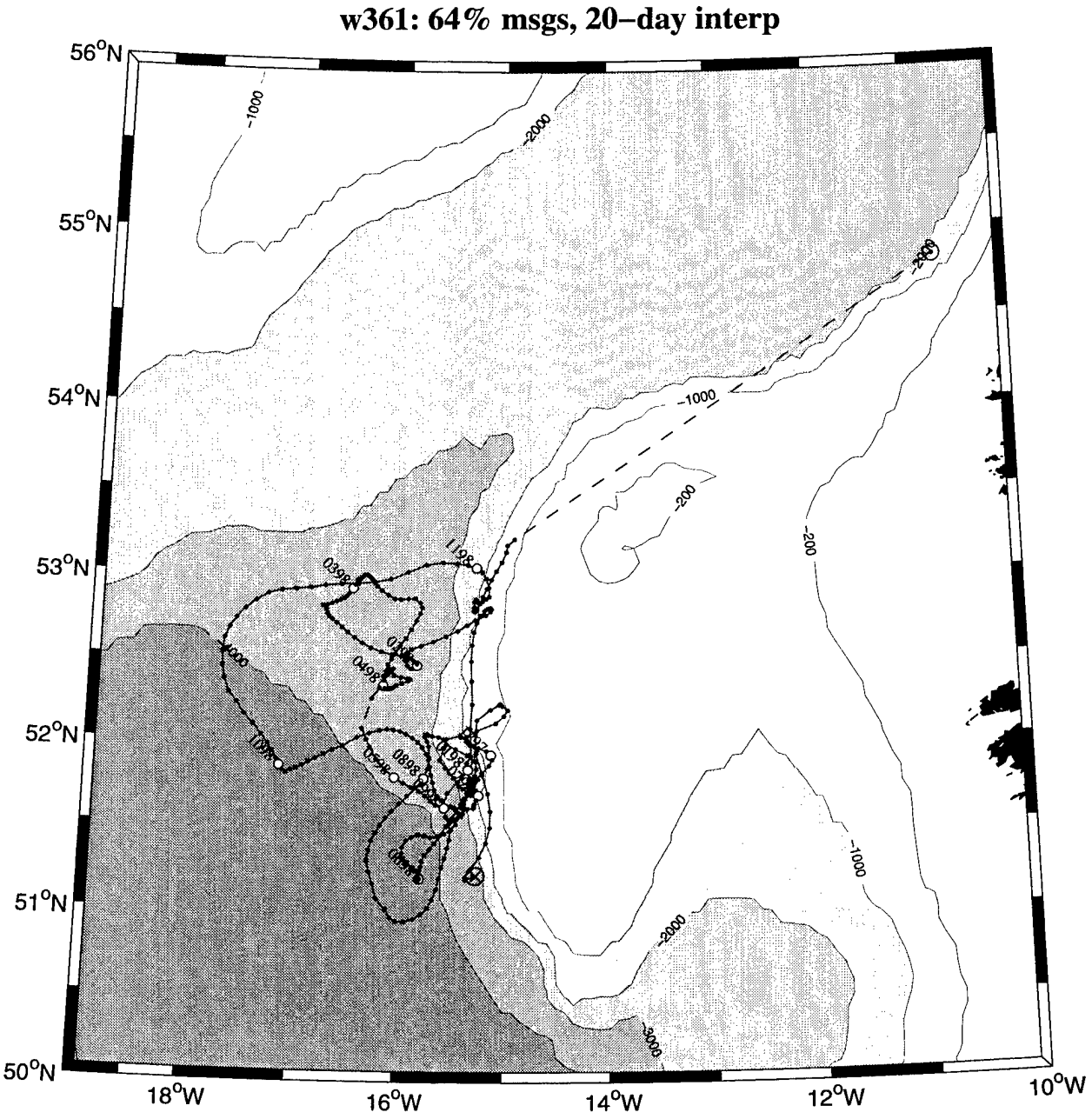

1998
1999
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
temperature (°C)
8
7
6
5
4
3
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w360: 84% msgs, 15–day interp

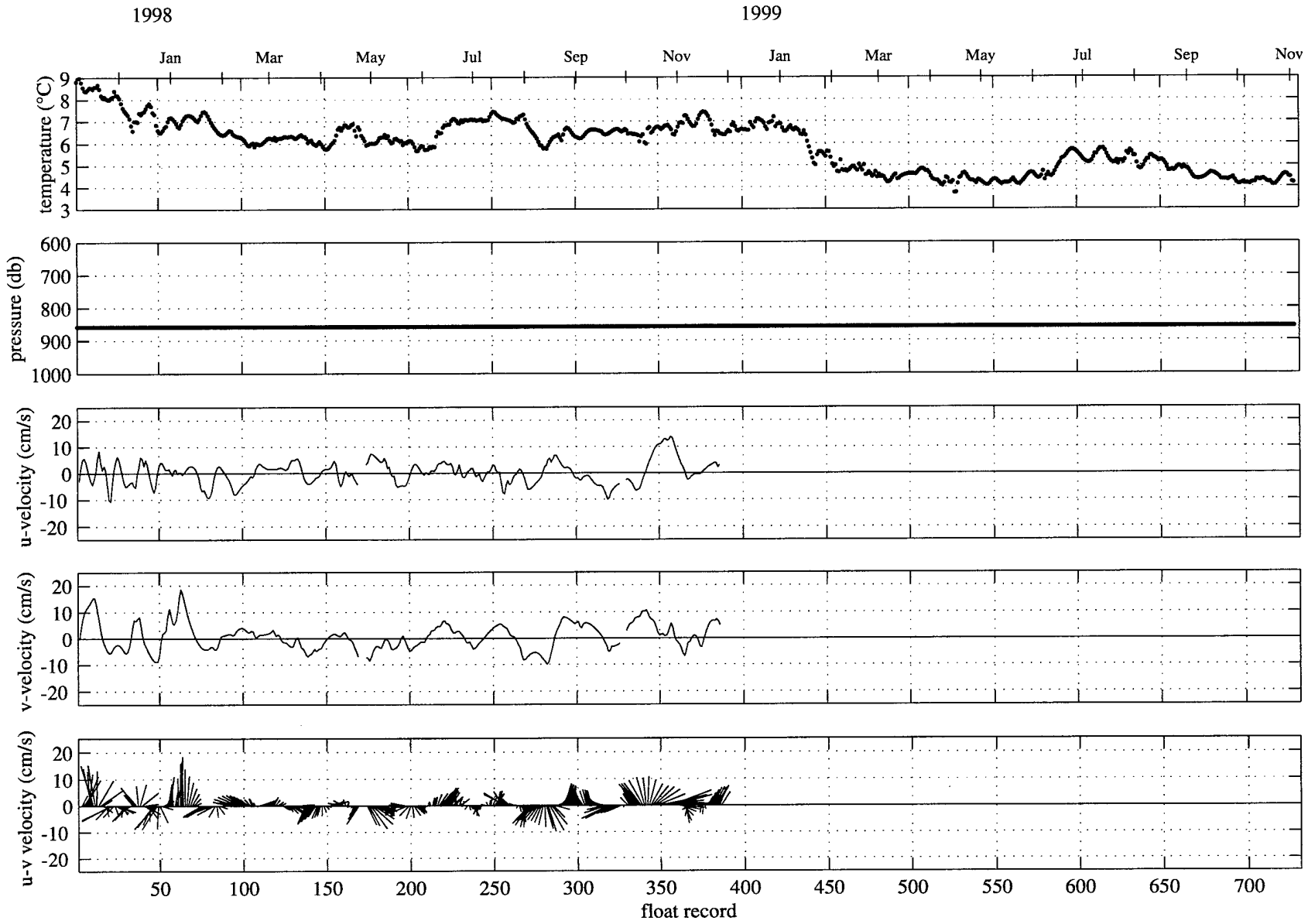


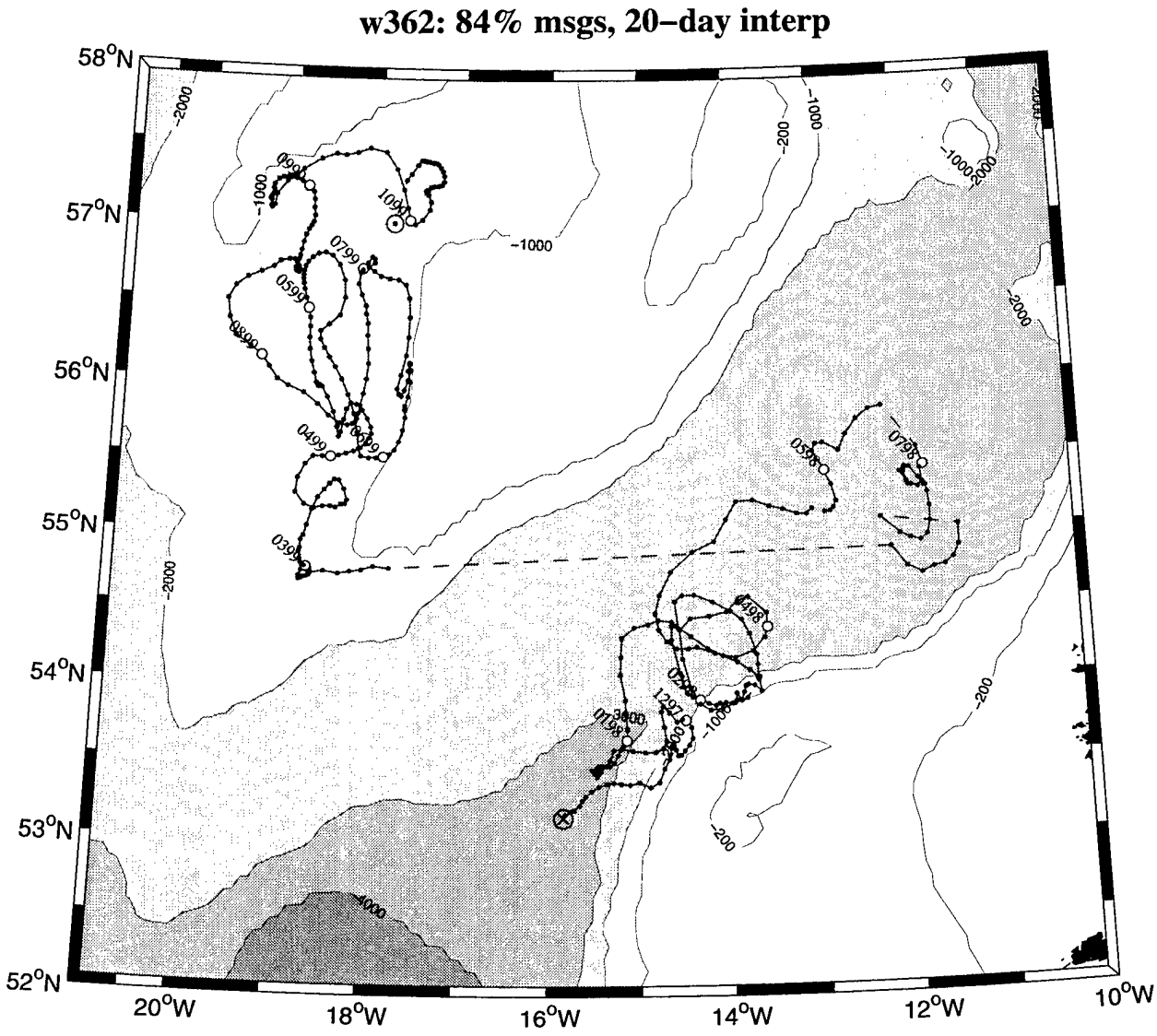
w360


1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
8
7
6
5
4
3
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

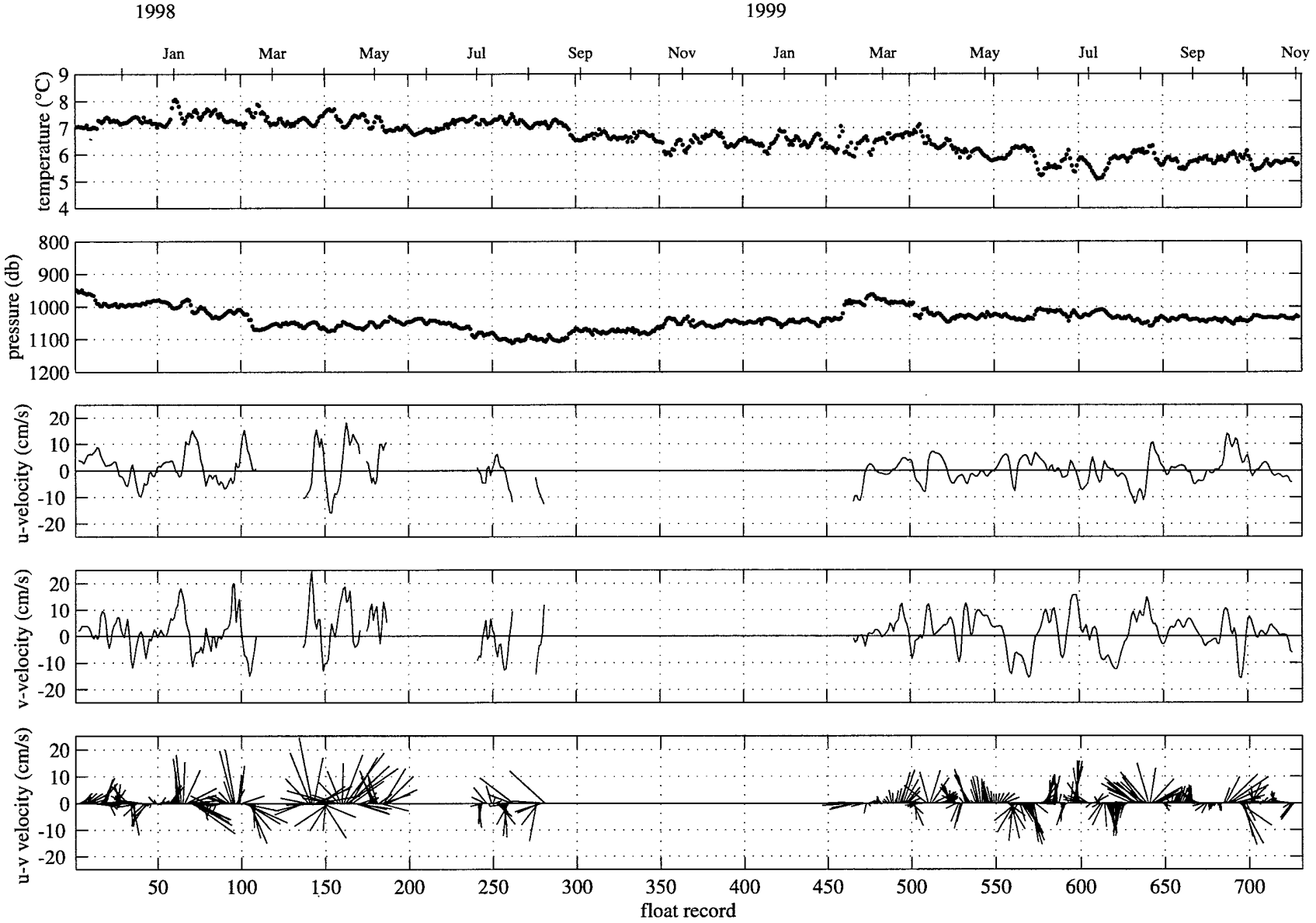

w361: 64% msgs, 20–day interp
56°N
55°N
54°N
53°N
52°N
51°N
50°N
18°W
16°W
14°W
12°W
10°W
-1000
-2000
-200
-3000

w361

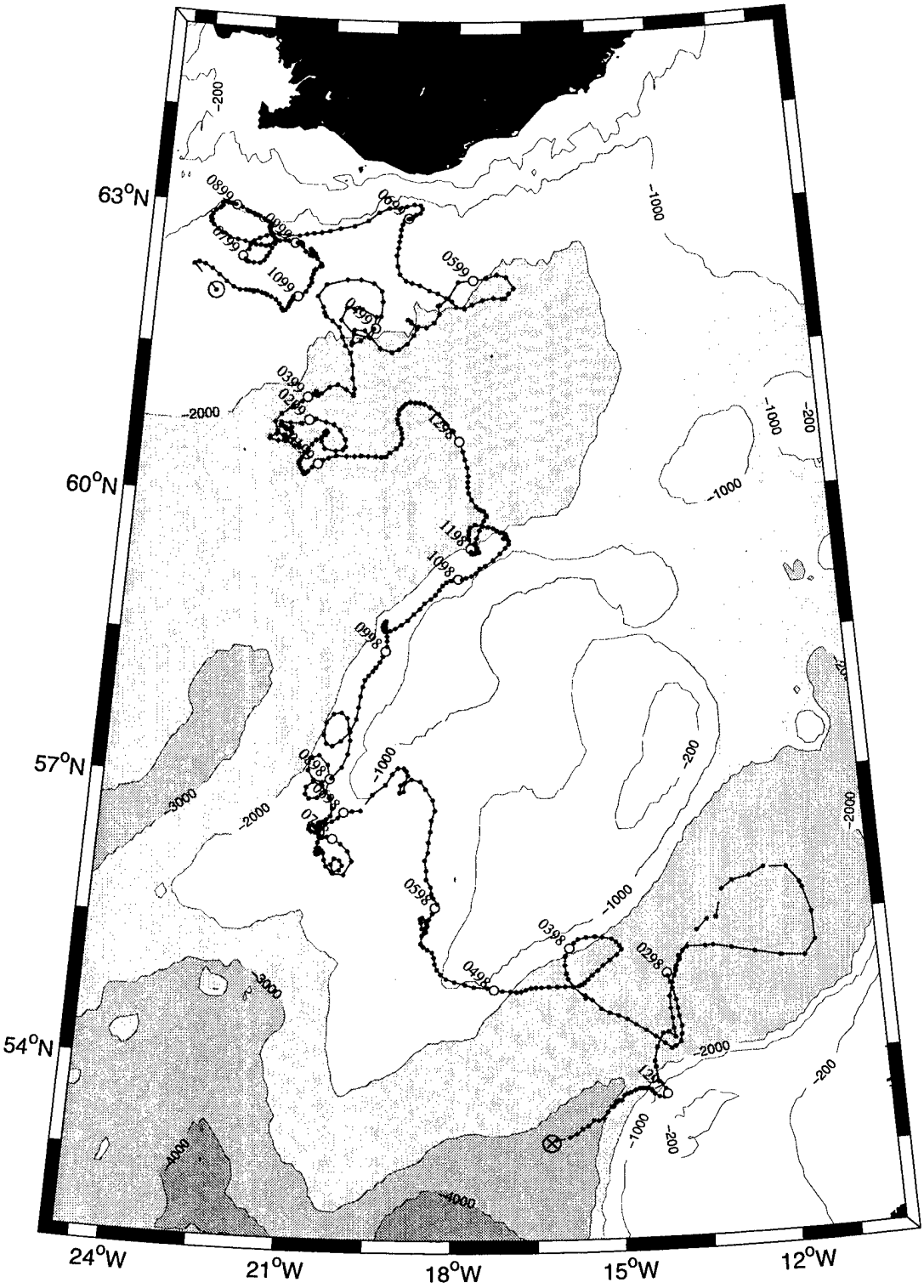

1998
1999
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
9
8
7
6
5
4
3
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w362: 84% msgs, 20–day interp
58°N
57°N
56°N
55°N
54°N
53°N
52°N
20°W
18°W
16°W
14°W
12°W
10°W
-2000
-1000
-200
4000

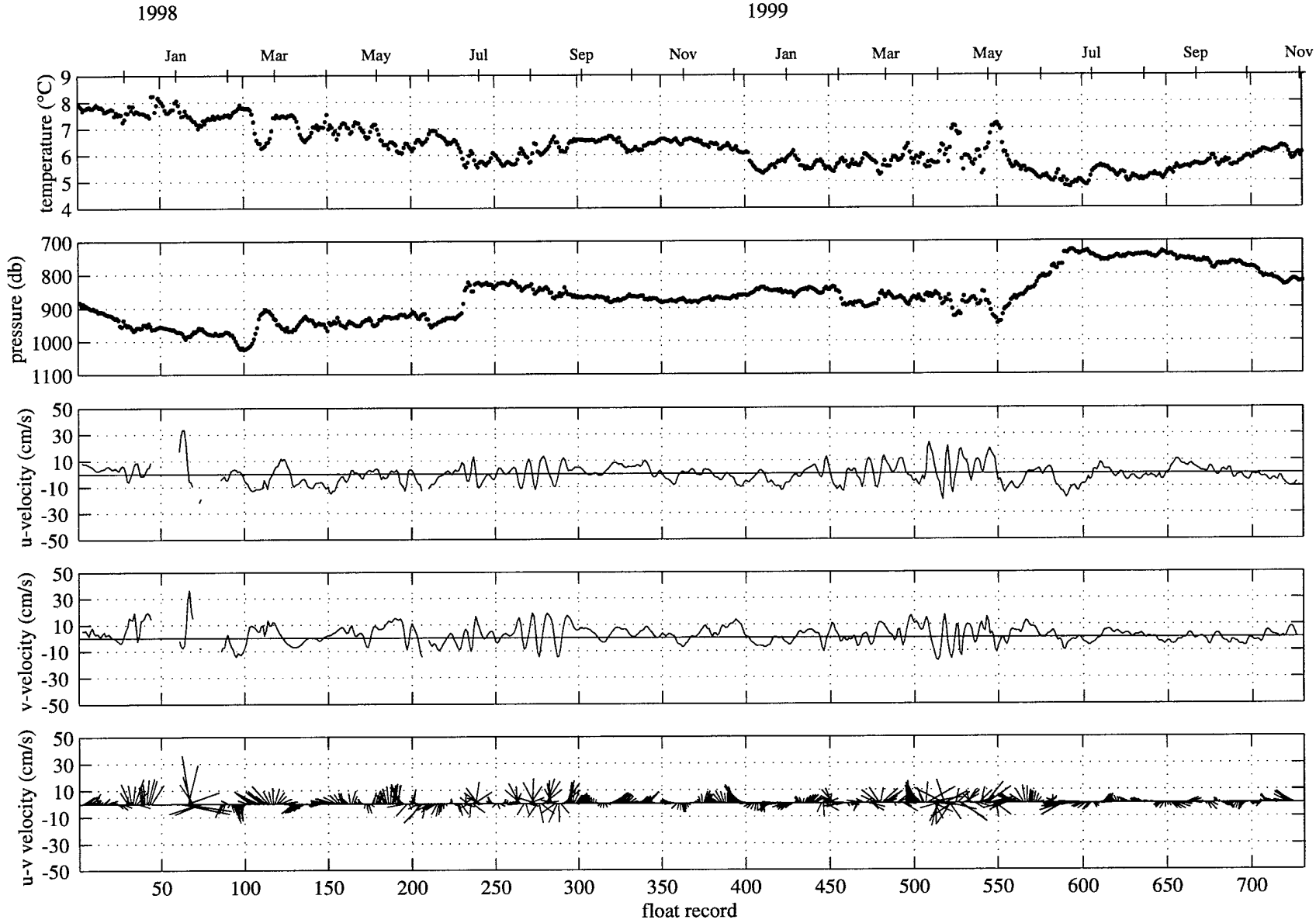
w362


1998
1999
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
9
8
7
6
5
4
pressure (db)
800
900
1000
1100
1200
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

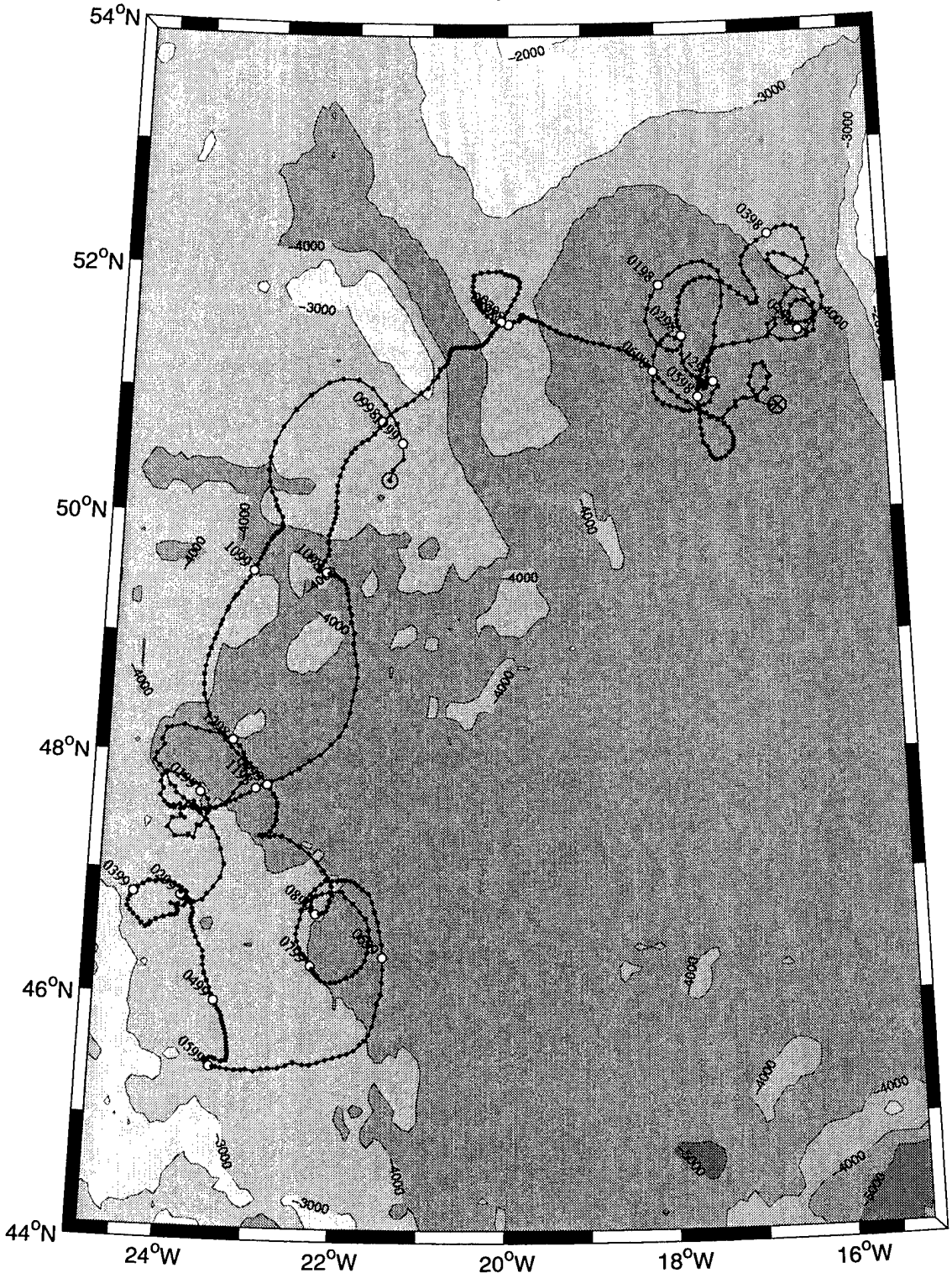
w363: 89% msgs, 20–day interp



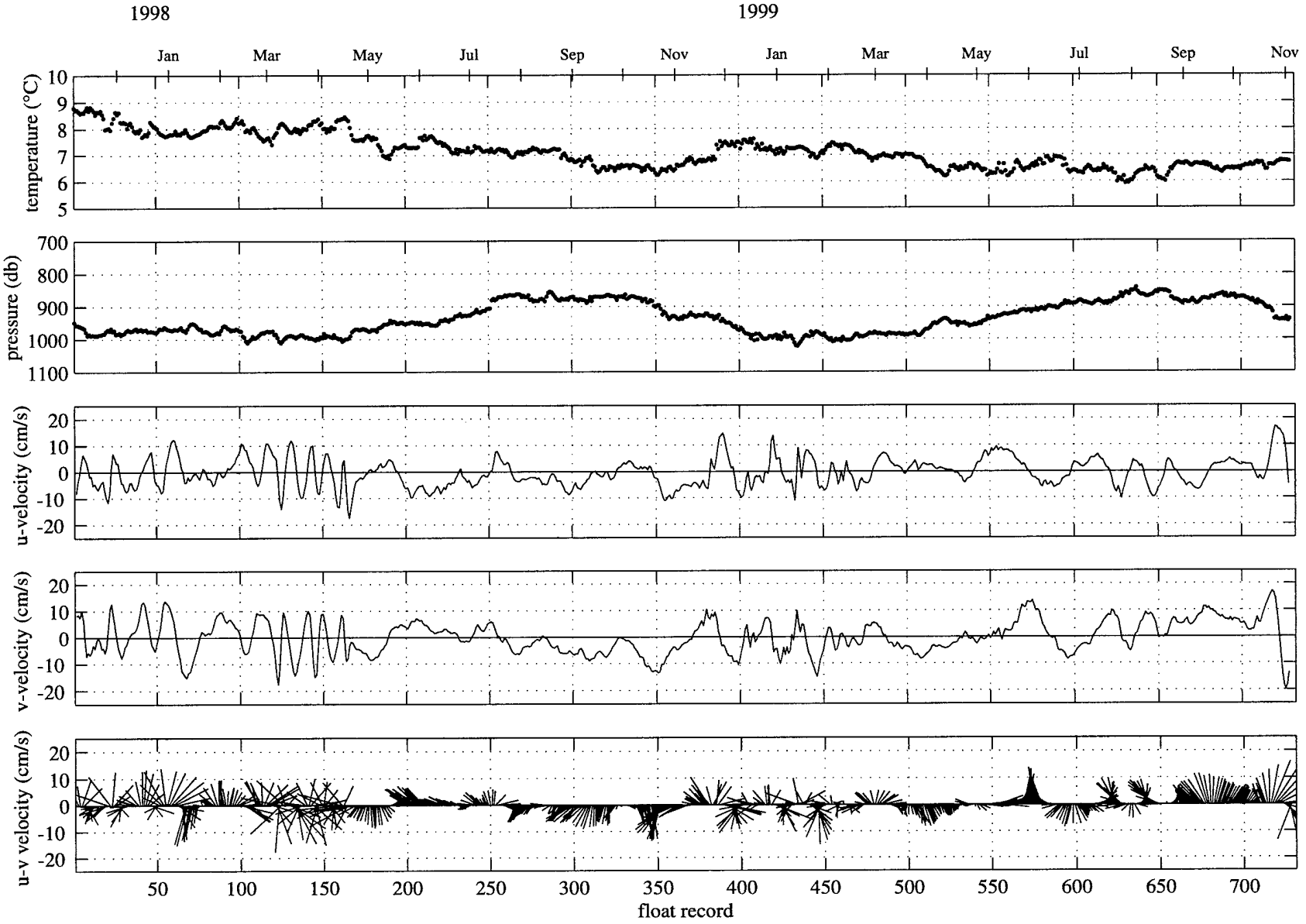
w363


1998
1999
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
9
8
7
6
5
4
pressure (db)
700
800
900
1000
1100
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

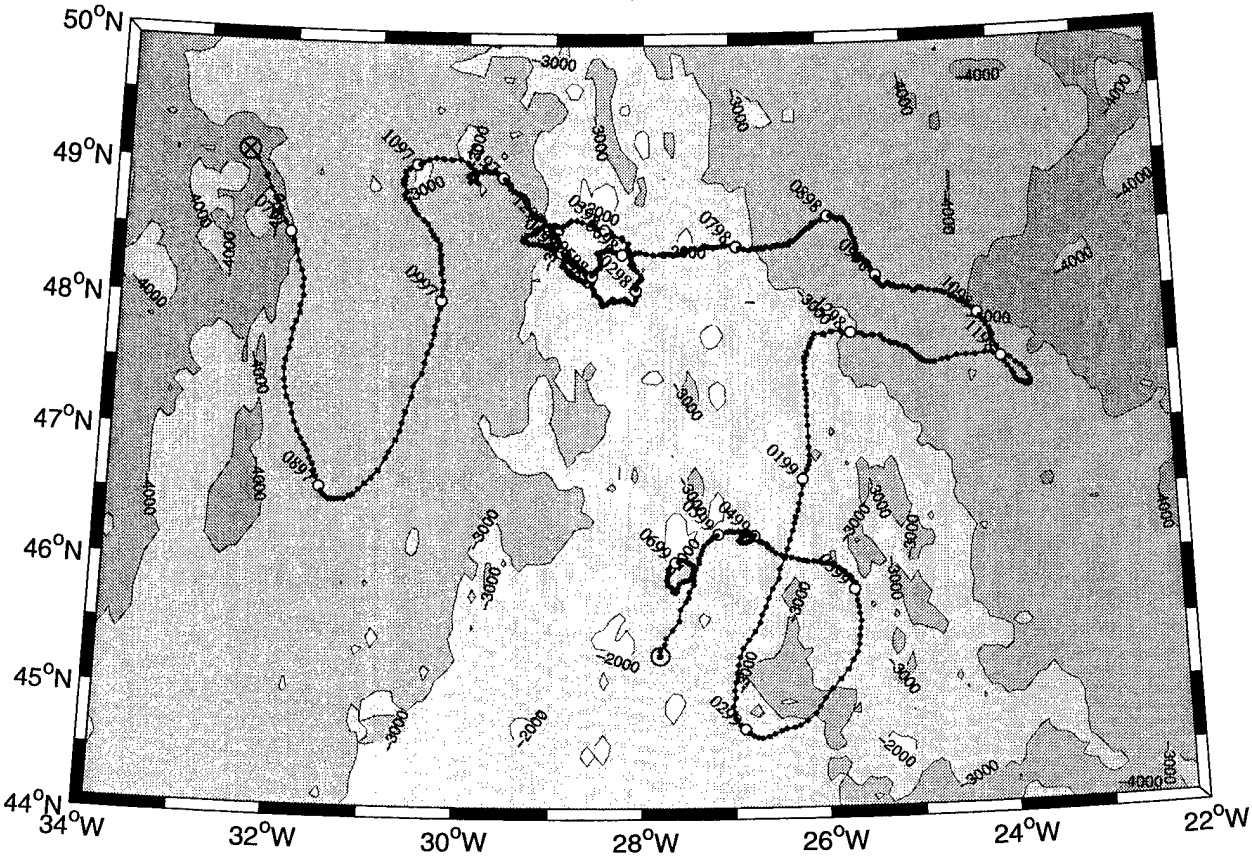
w364: 86% msgs, 10–day interp



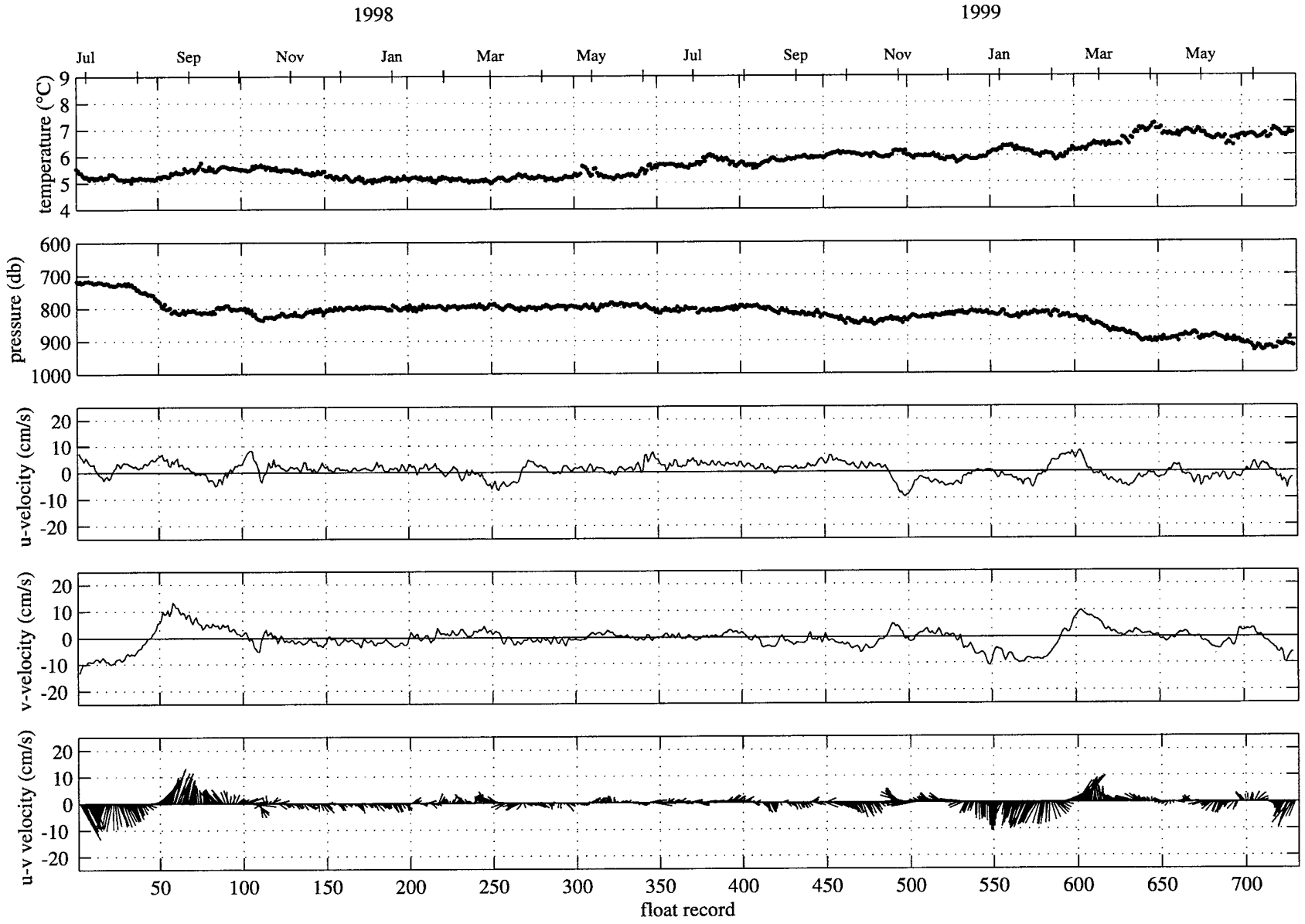
w364


1998
1999
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
10
9
8
7
6
5
pressure (db)
700
800
900
1000
1100
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

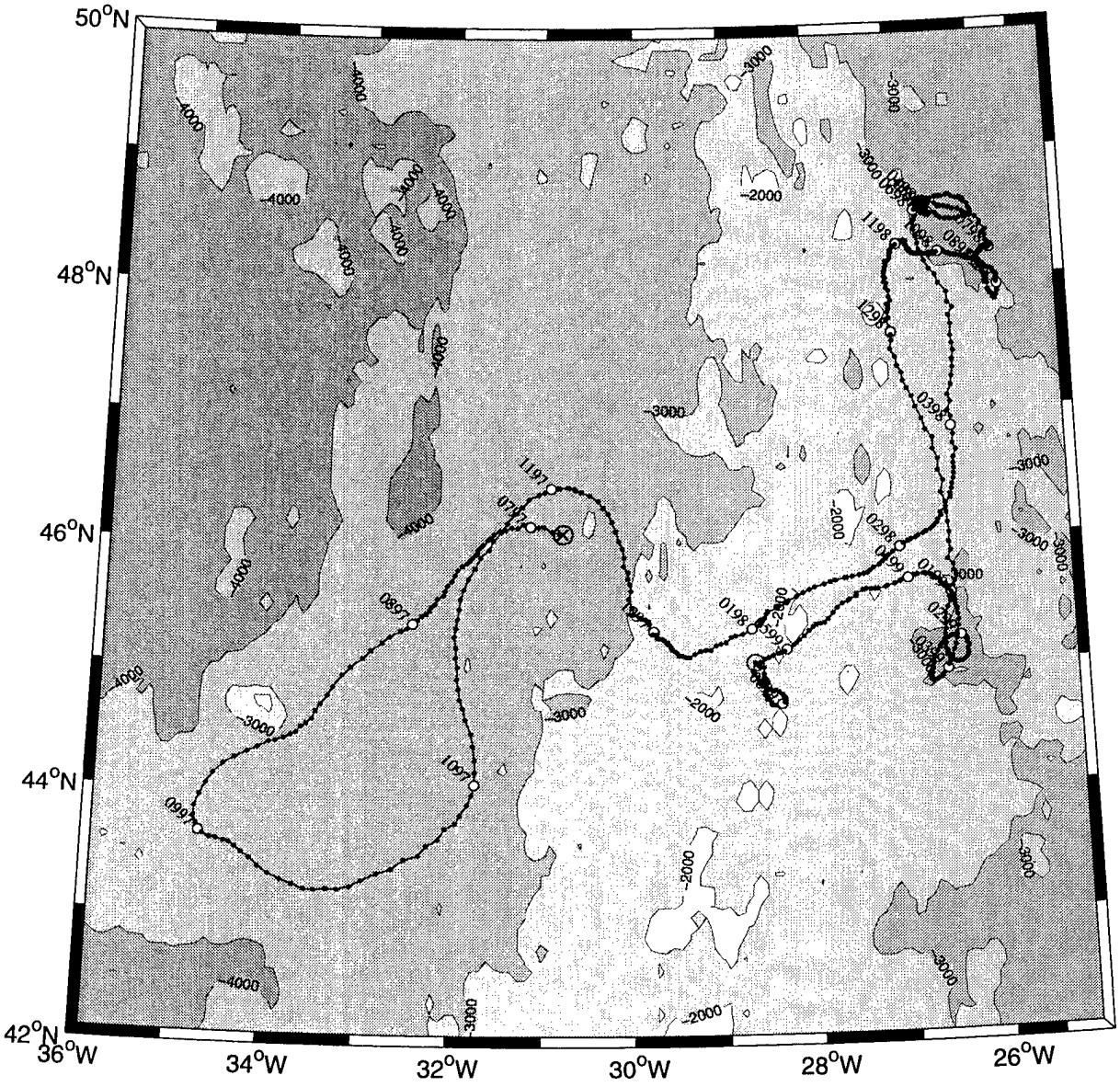
w365: 92% msgs, 10–day interp



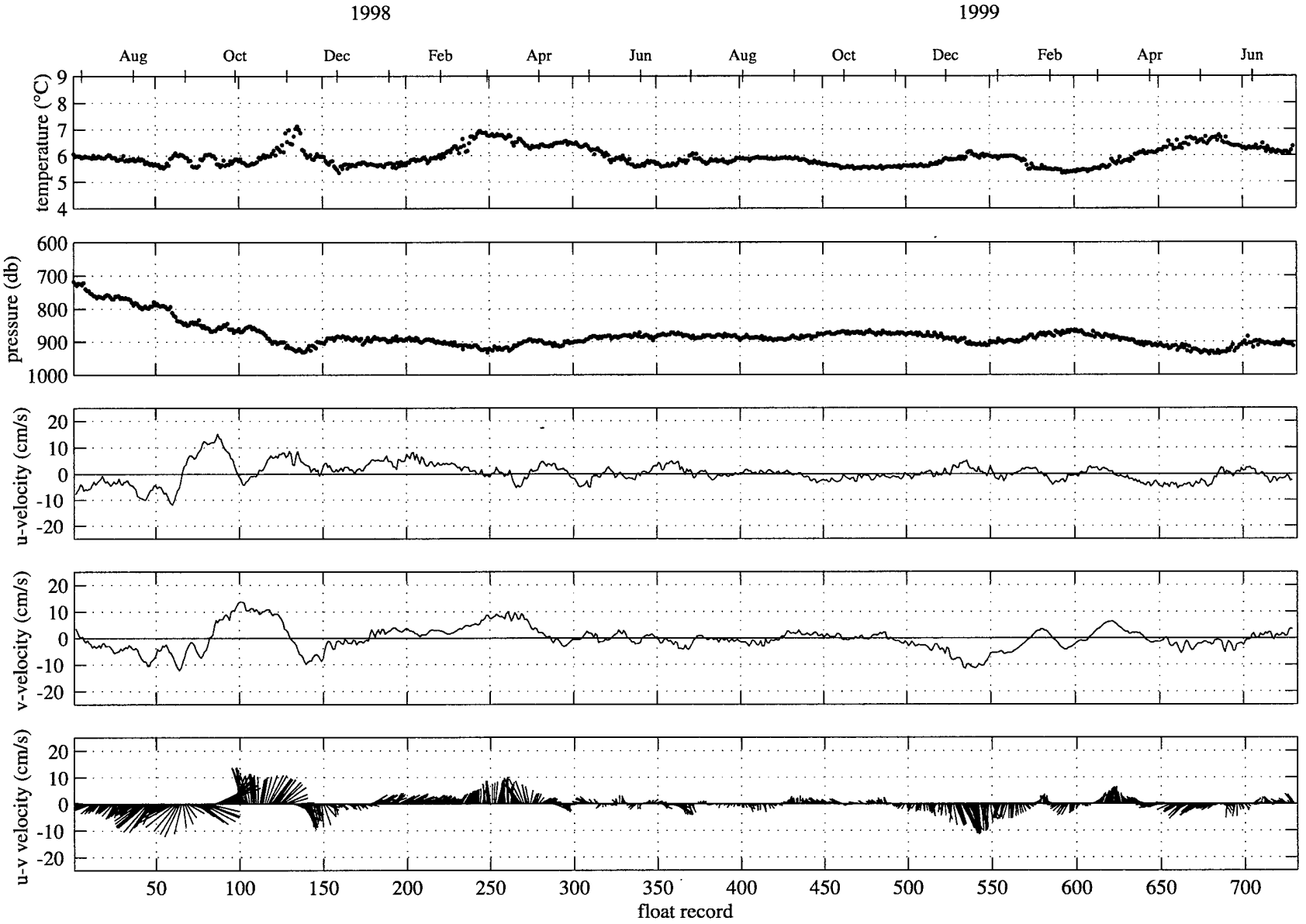
w365


1998
1999
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
temperature (°C)
9
8
7
6
5
4
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

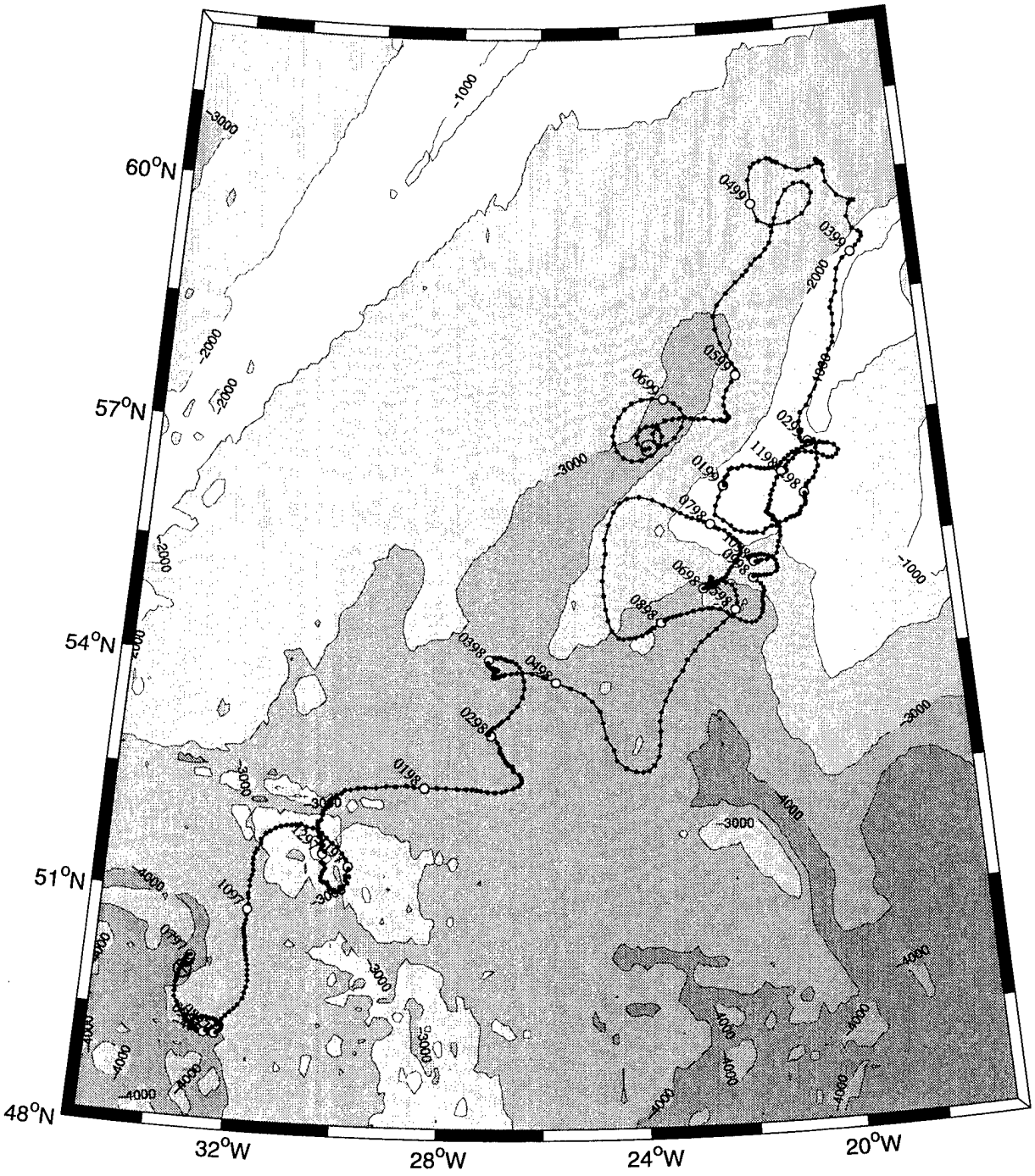
w367: 97% msgs, 15–day interp



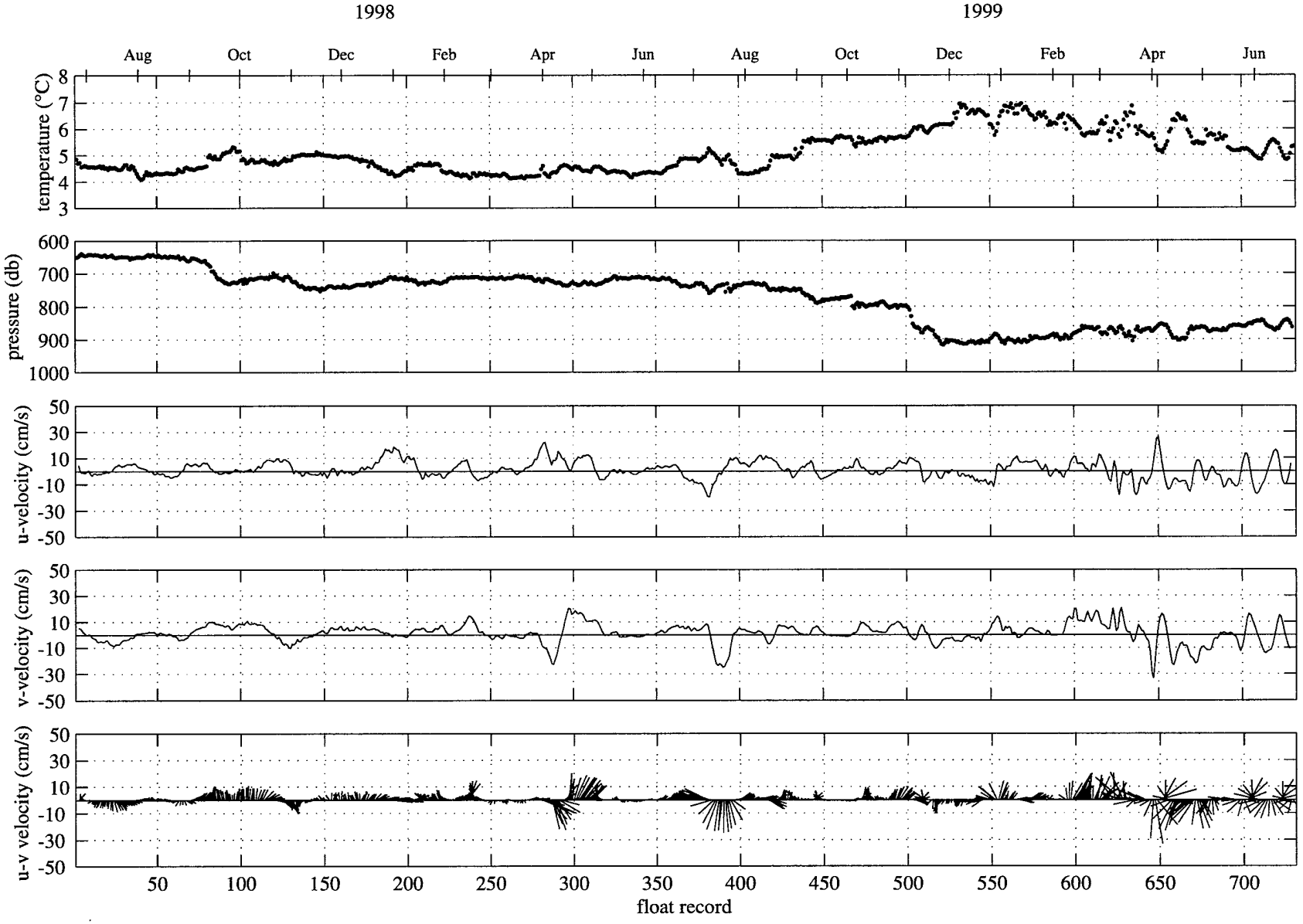
w367


1998
1999
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
temperature (°C)
9
8
7
6
5
4
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

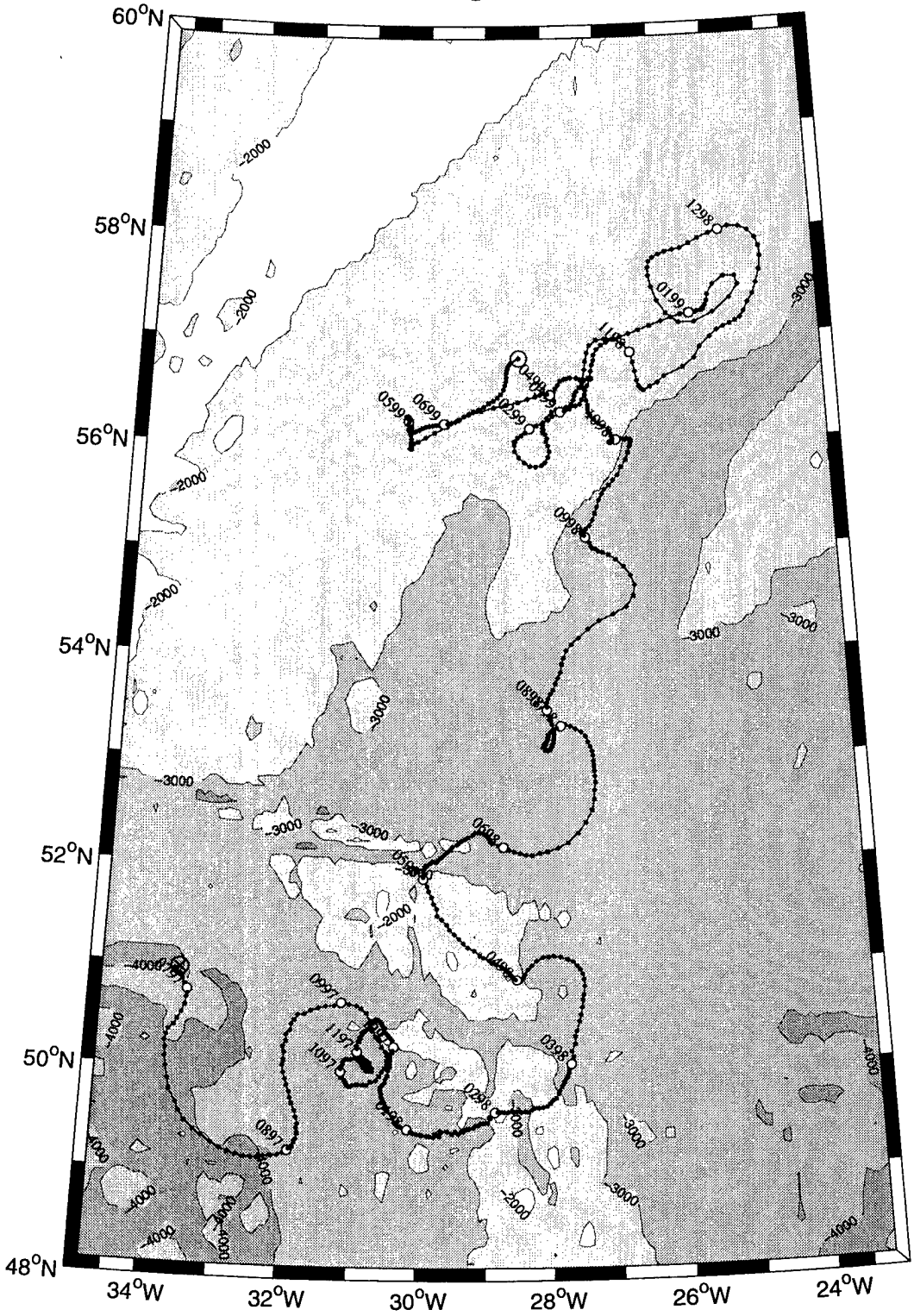
w368: 86% msgs, 10–day interp



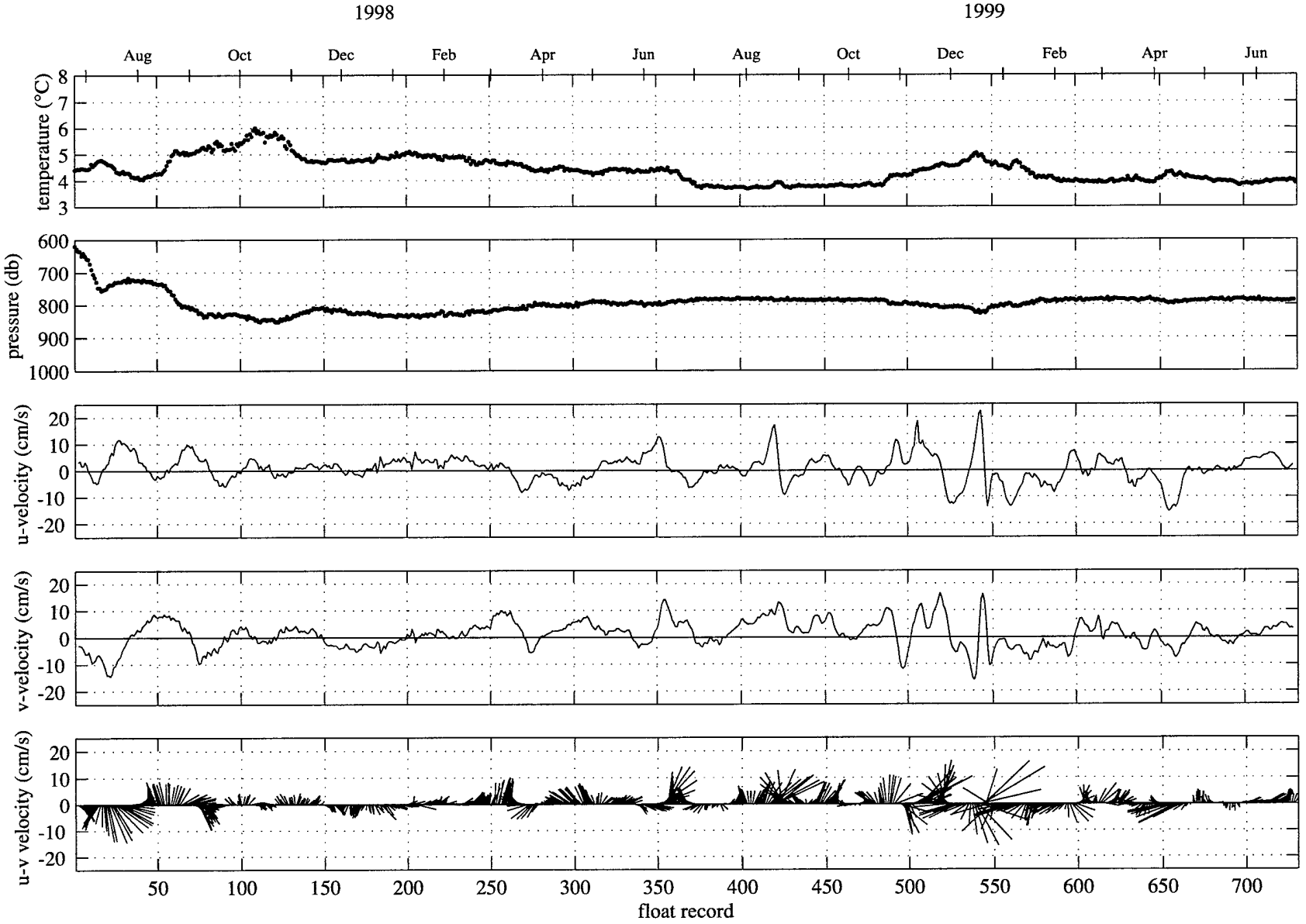
w368

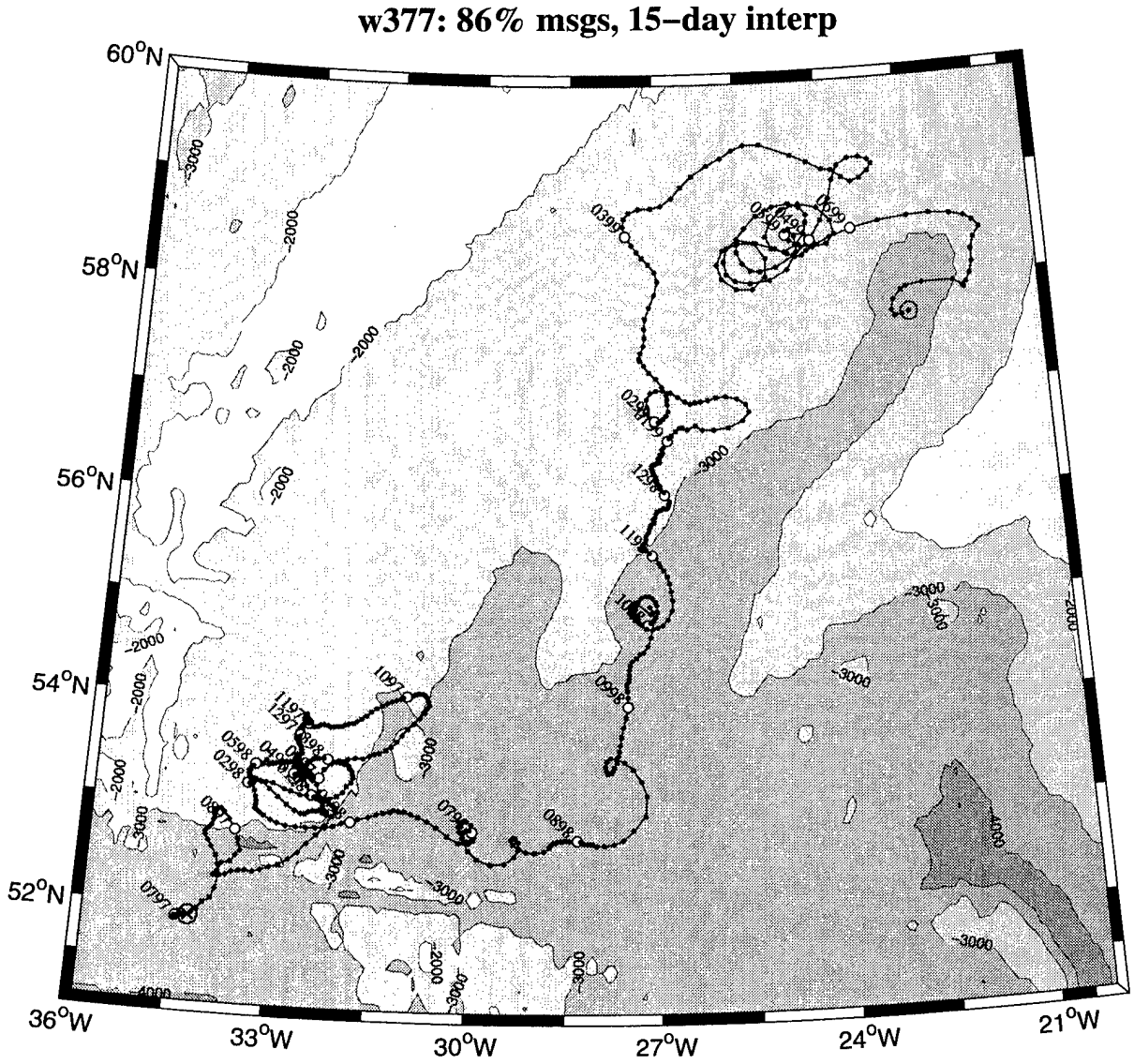

1998
1999
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
temperature (°C)
8
7
6
5
4
3
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w369: 96% msgs, 10–day interp

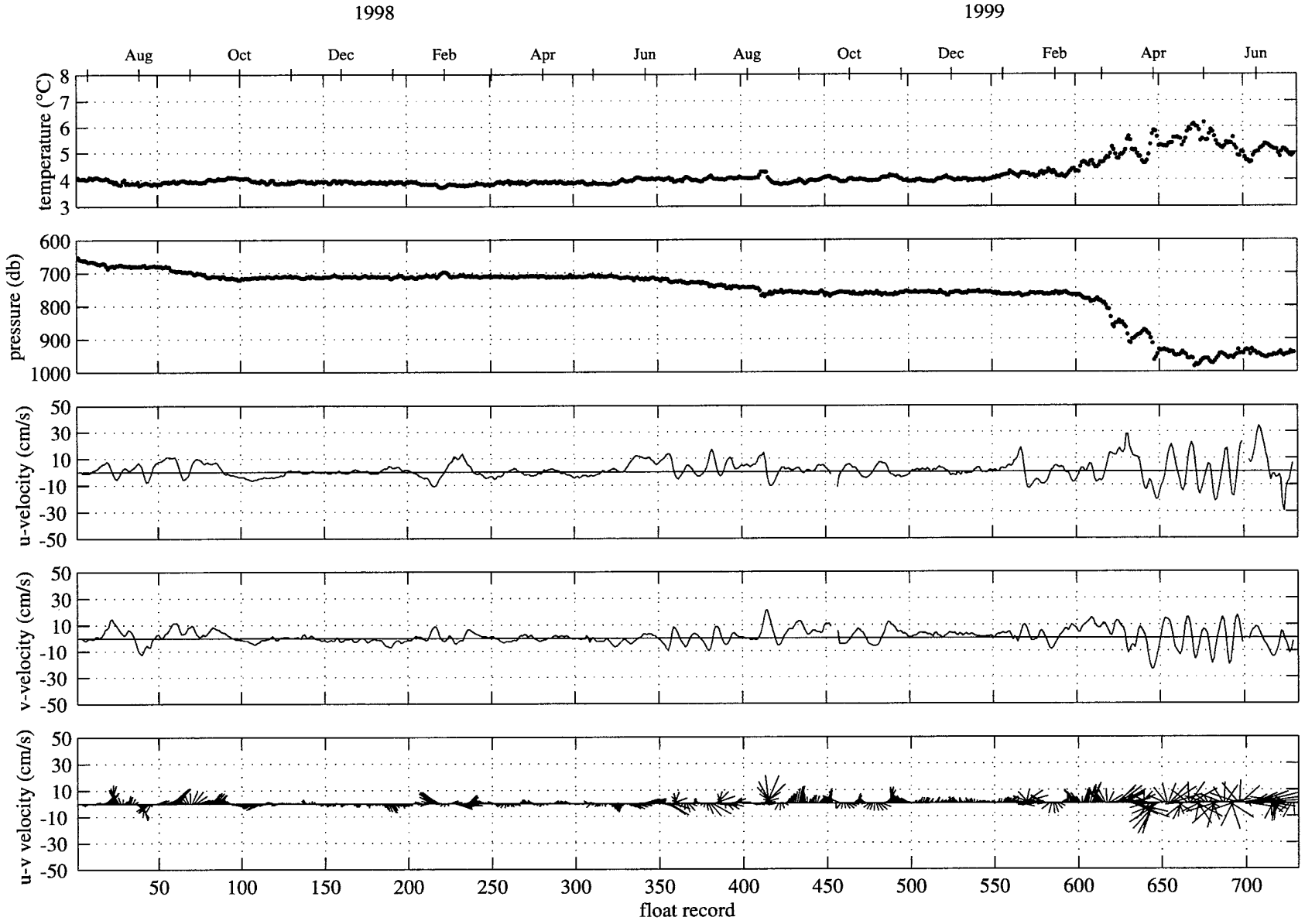


w369

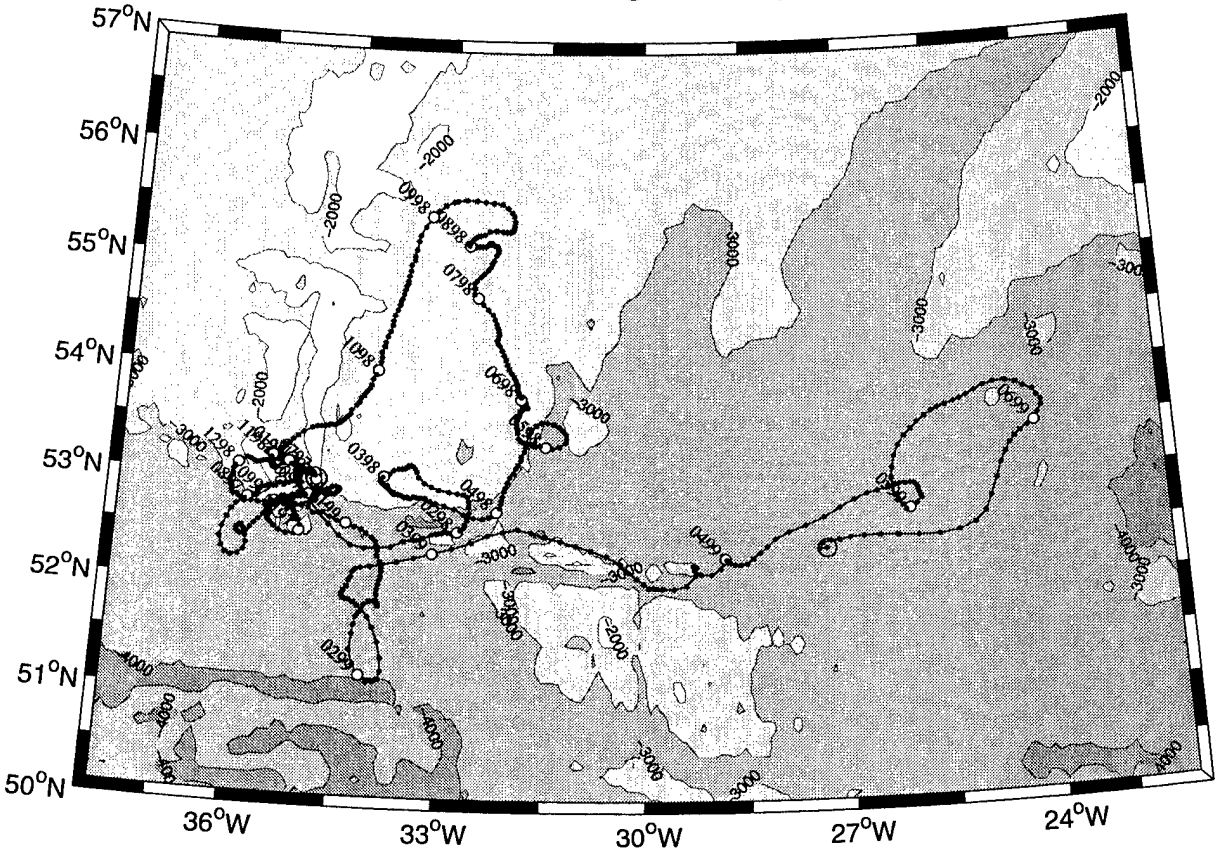

1998
1999
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
temperature (°C)
8
7
6
5
4
3
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w377: 86% msgs, 15-day interp
60°N
58°N
56°N
54°N
52°N
36°W
33°W
30°W
27°W
24°W
21°W

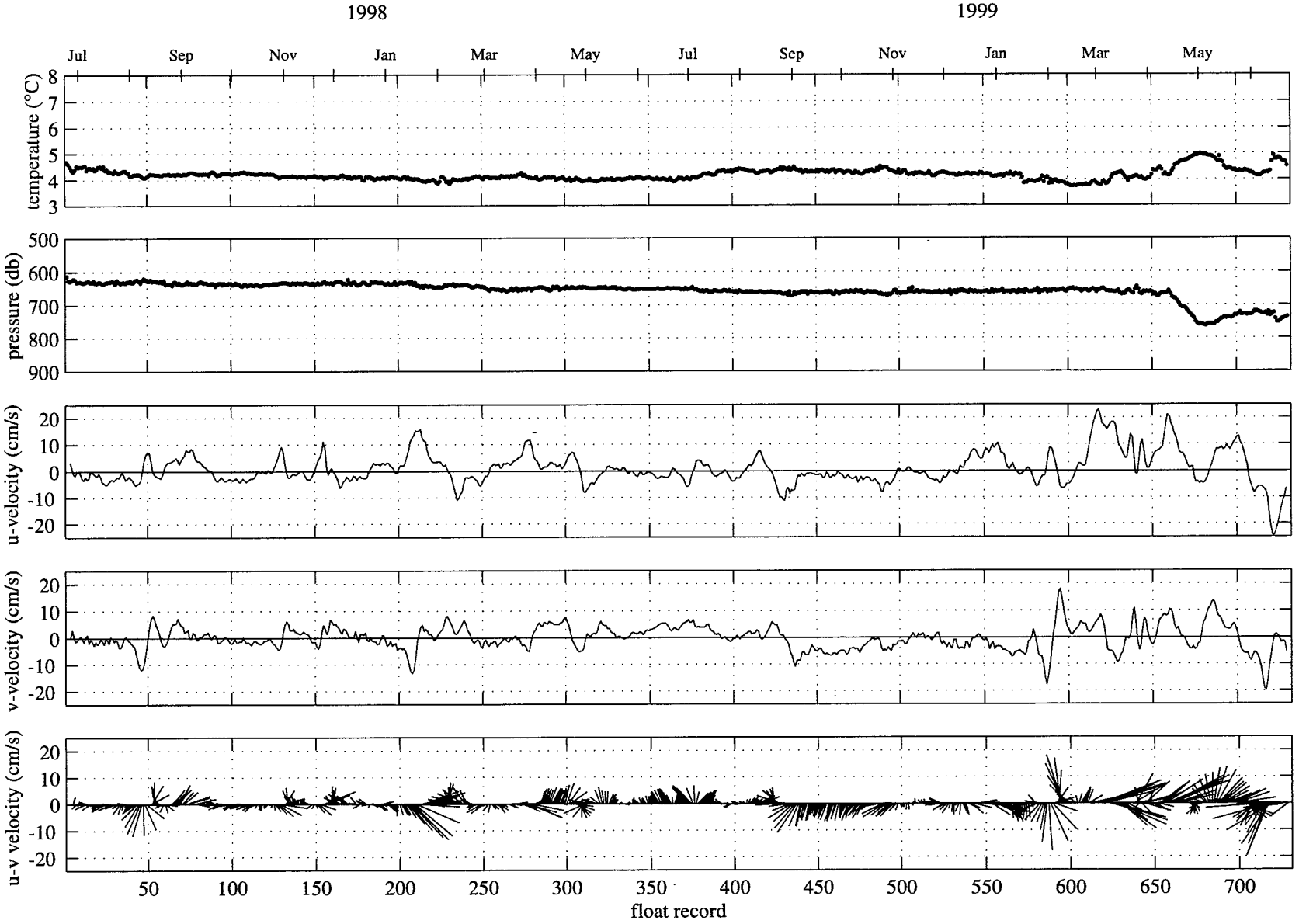
w377


1998
1999
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
temperature (°C)
8
7
6
5
4
3
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

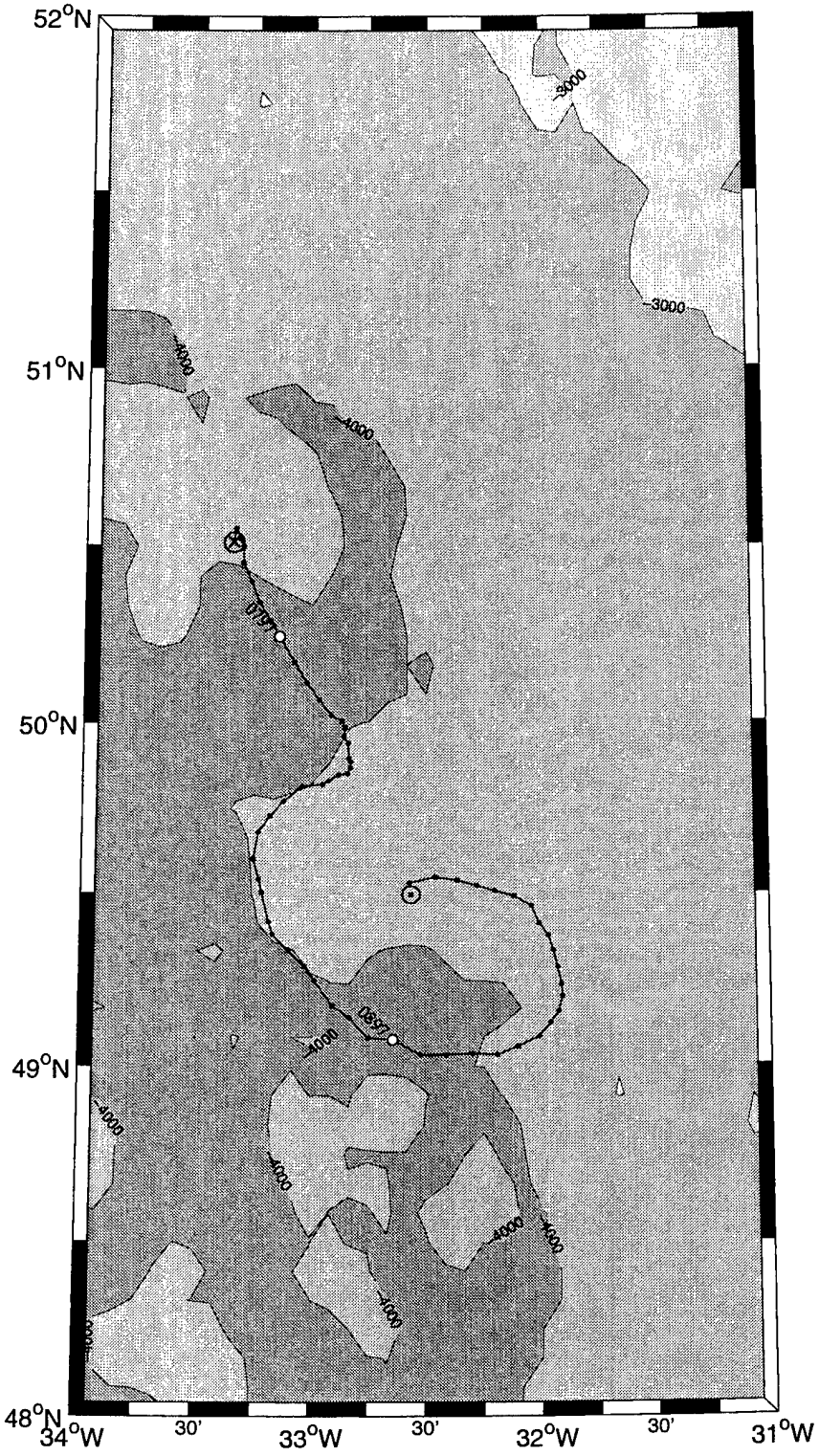
w378: 88% msgs, 10–day interp



w378

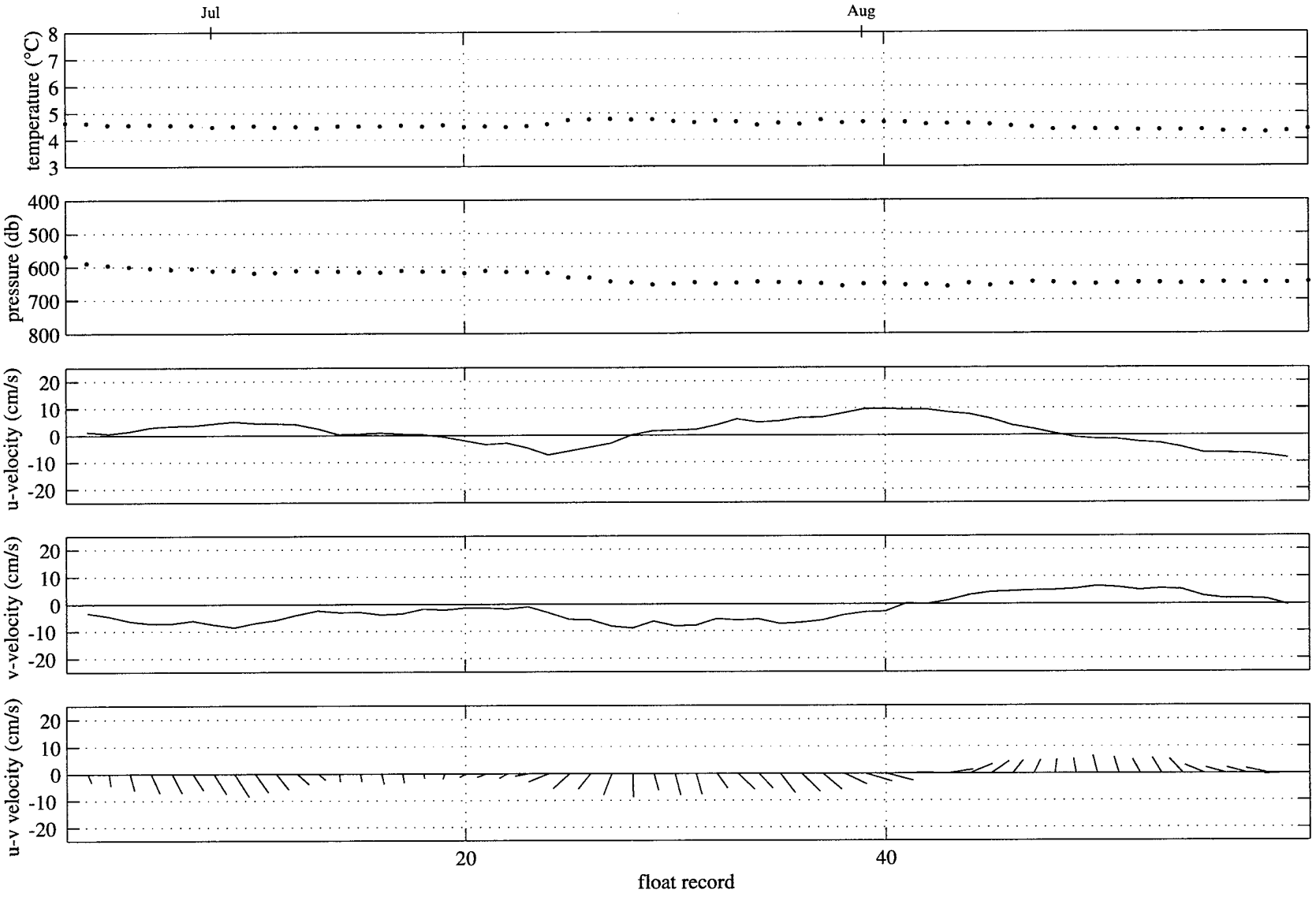

1998
1999
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
temperature (°C)
8
7
6
5
4
3
pressure (db)
500
600
700
800
900
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w380: 100% msgs, 5–day interp

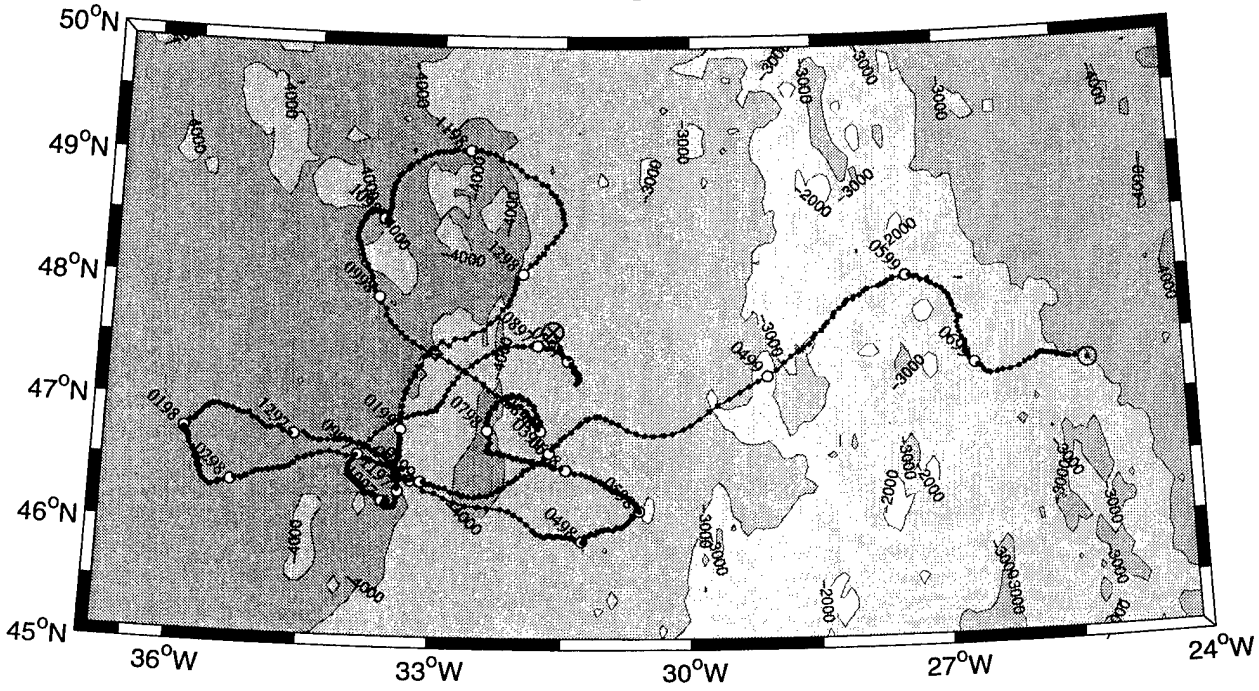


w380

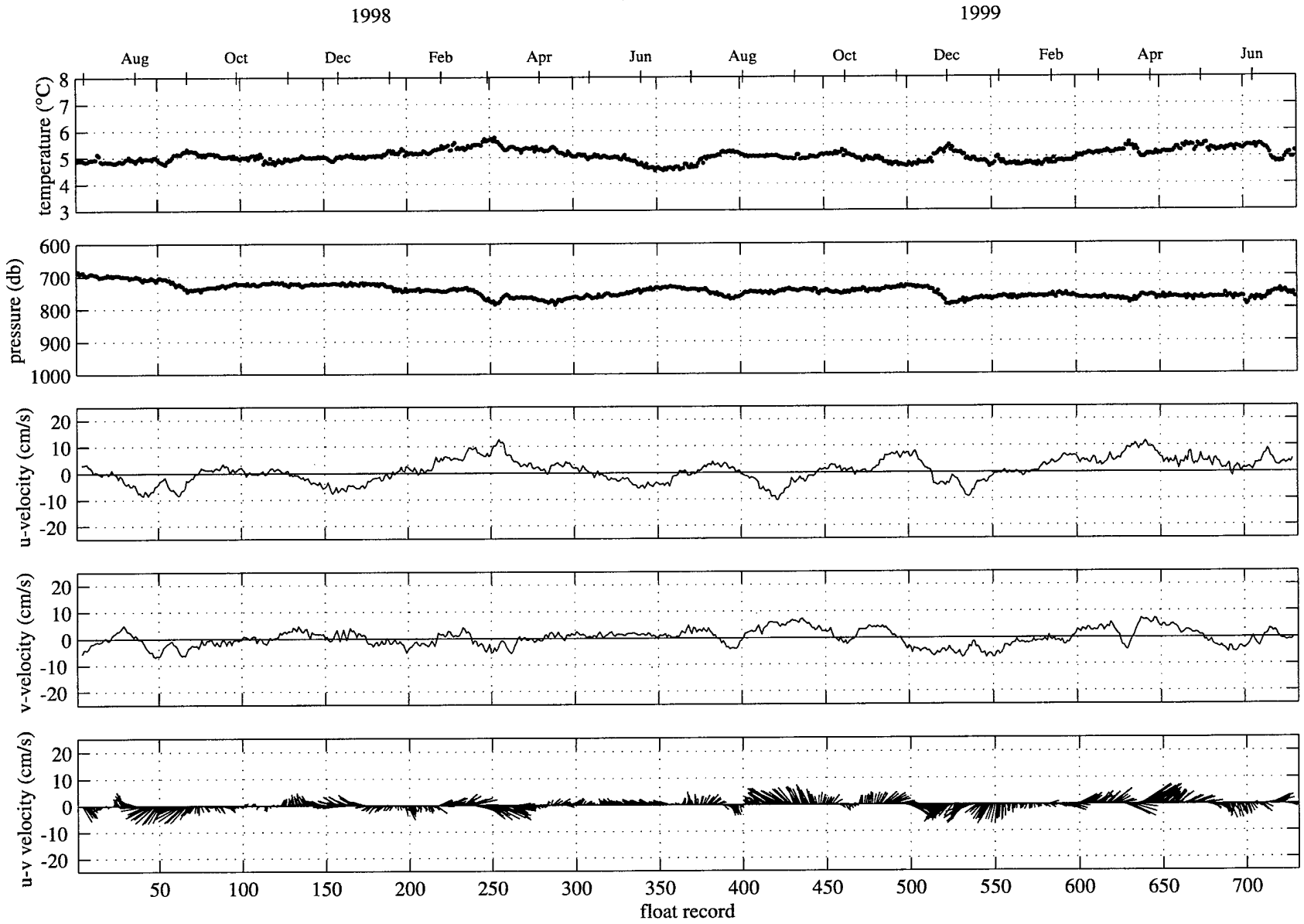
1997

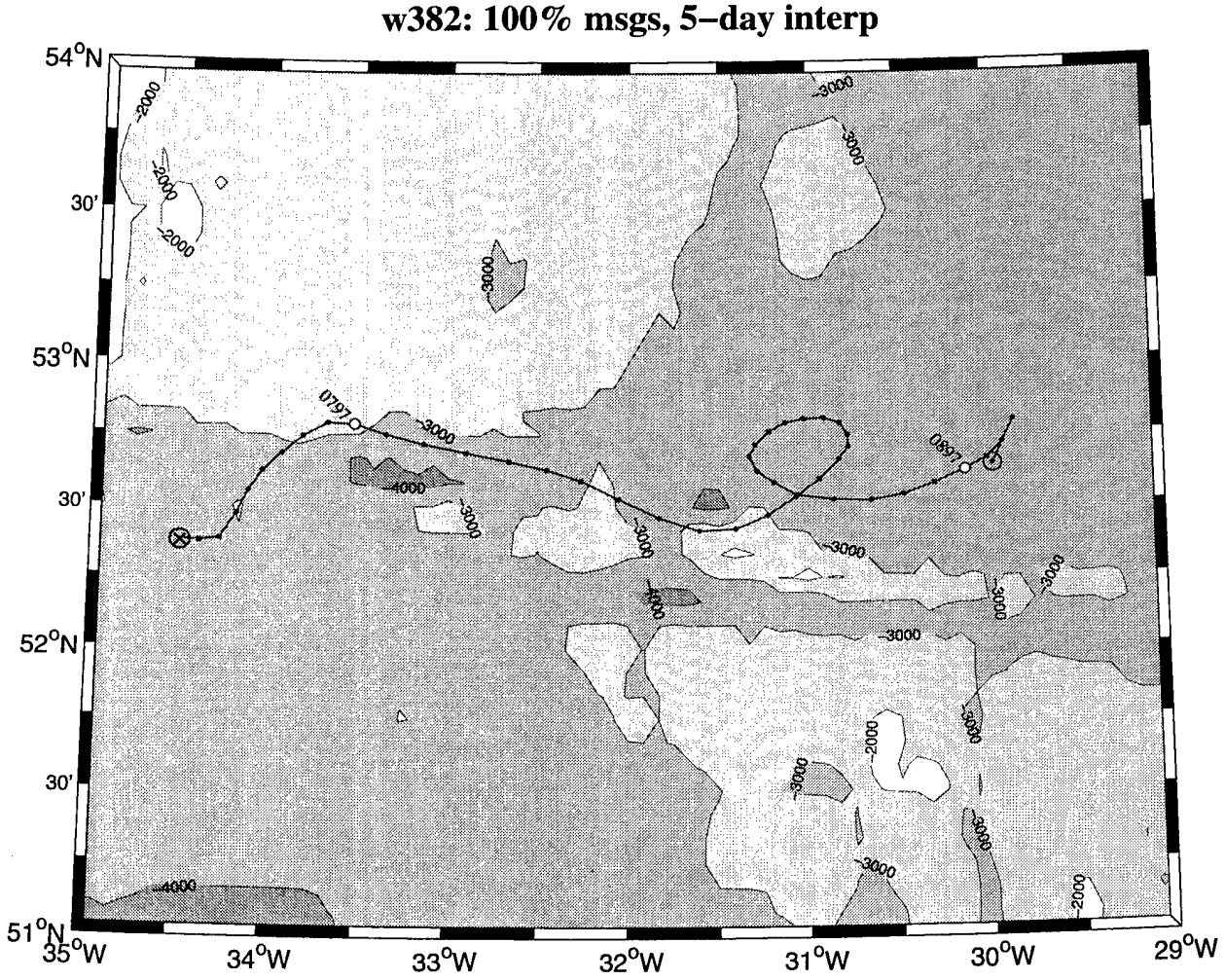

Jul
Aug
temperature (°C)
8
7
6
5
4
3
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
20
40
float record

w381: 94% msgs, 10–day interp

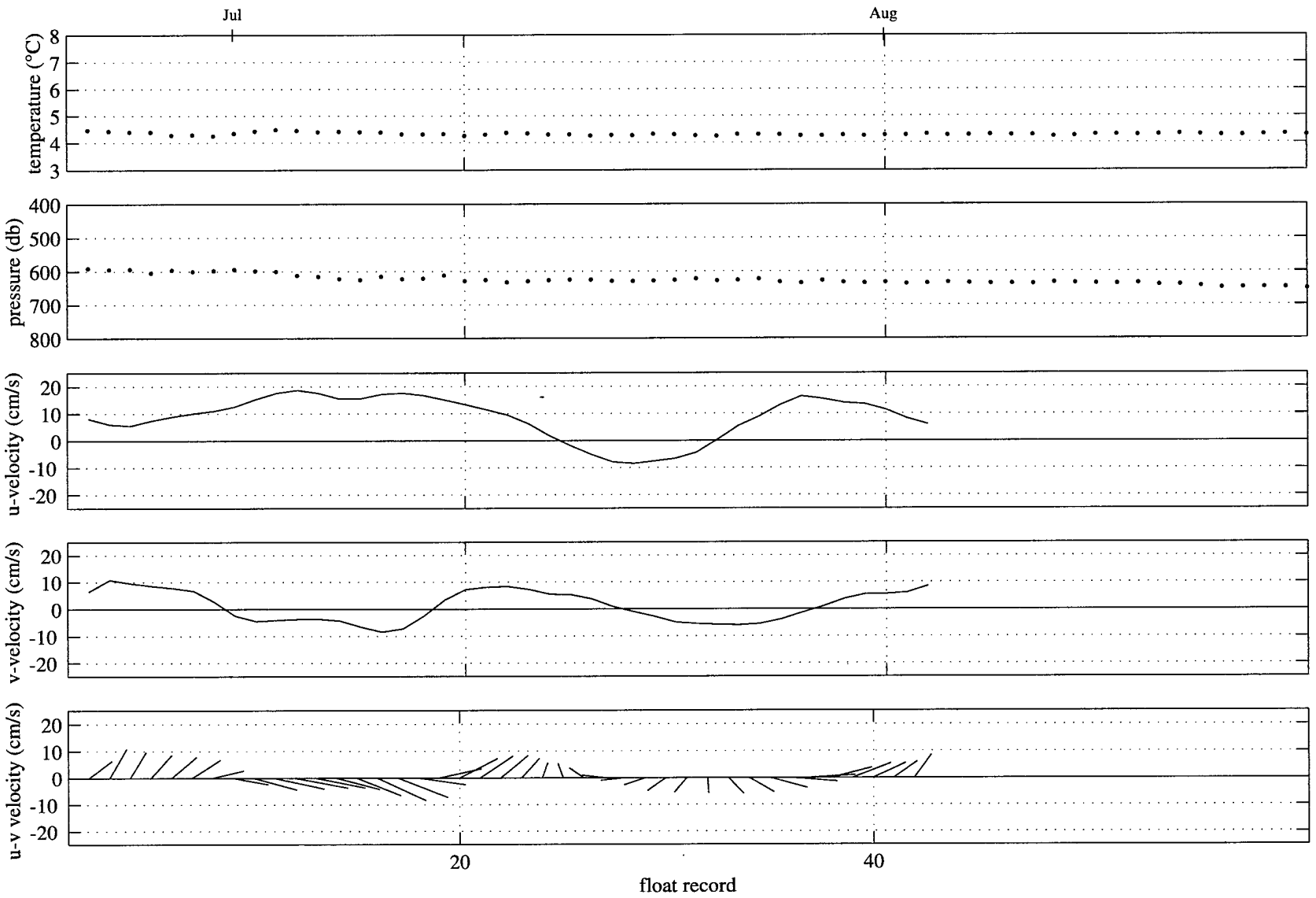


w381

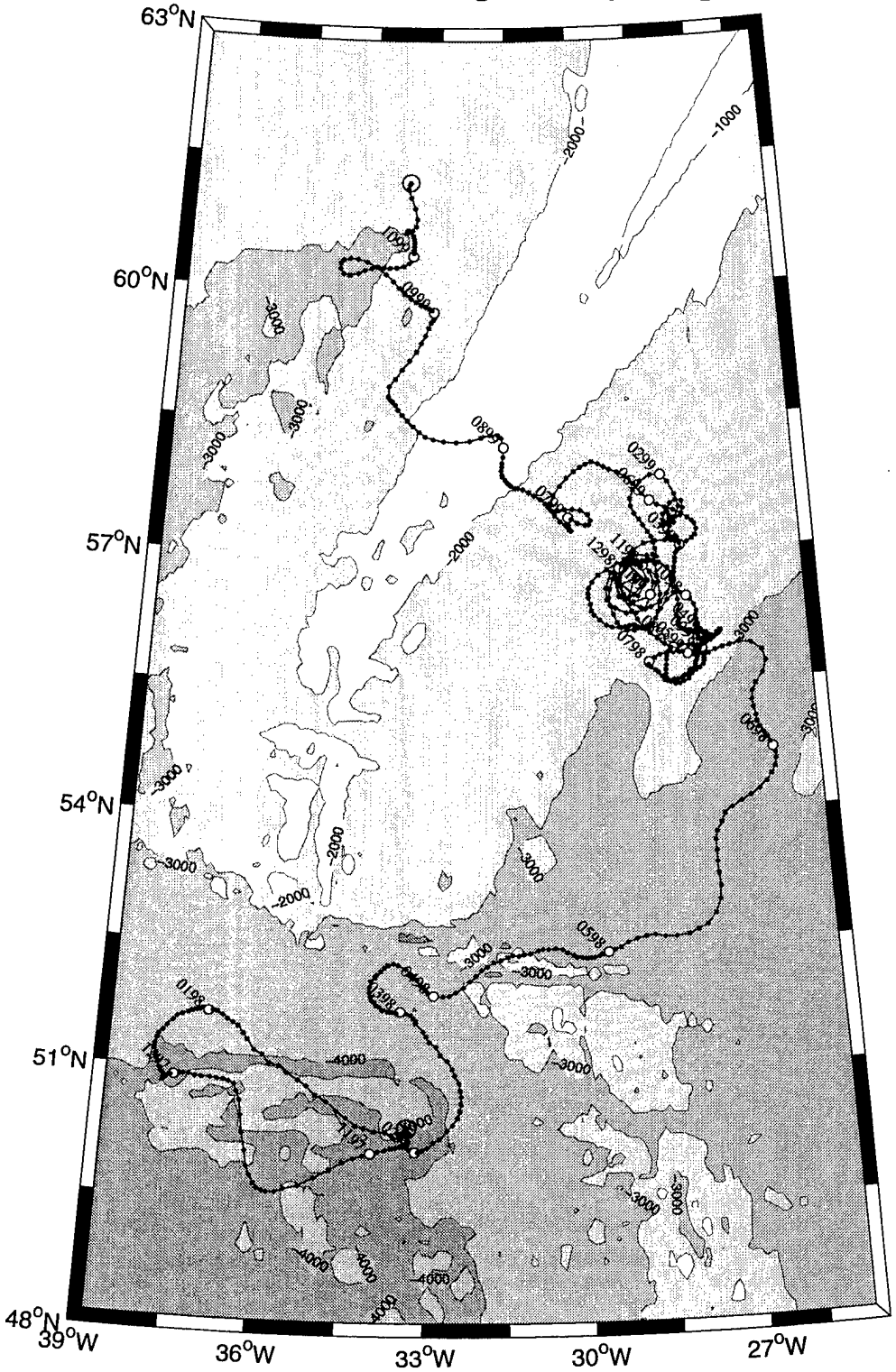

1998
1999
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
temperature (°C)
8
7
6
5
4
3
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w382: 100% msgs, 5-day interp
54°N
30'
53°N
30'
52°N
30'
51°N
35°W
34°W
33°W
32°W
31°W
30°W
29°W
07/97
08/97
-2000
-3000
-4000

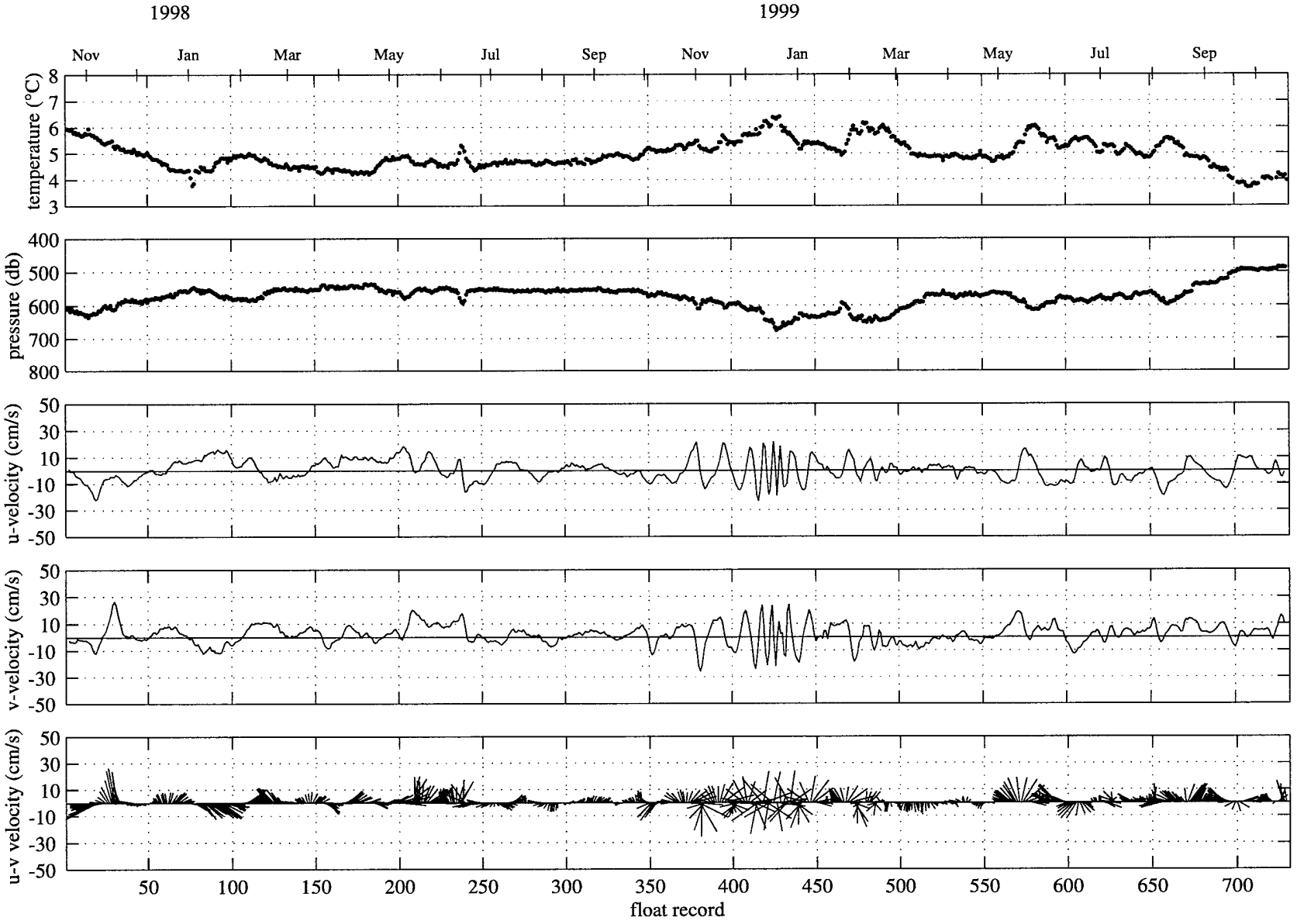
w382


1997
Jul
Aug
temperature (°C)
8
7
6
5
4
3
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
20
40
float record

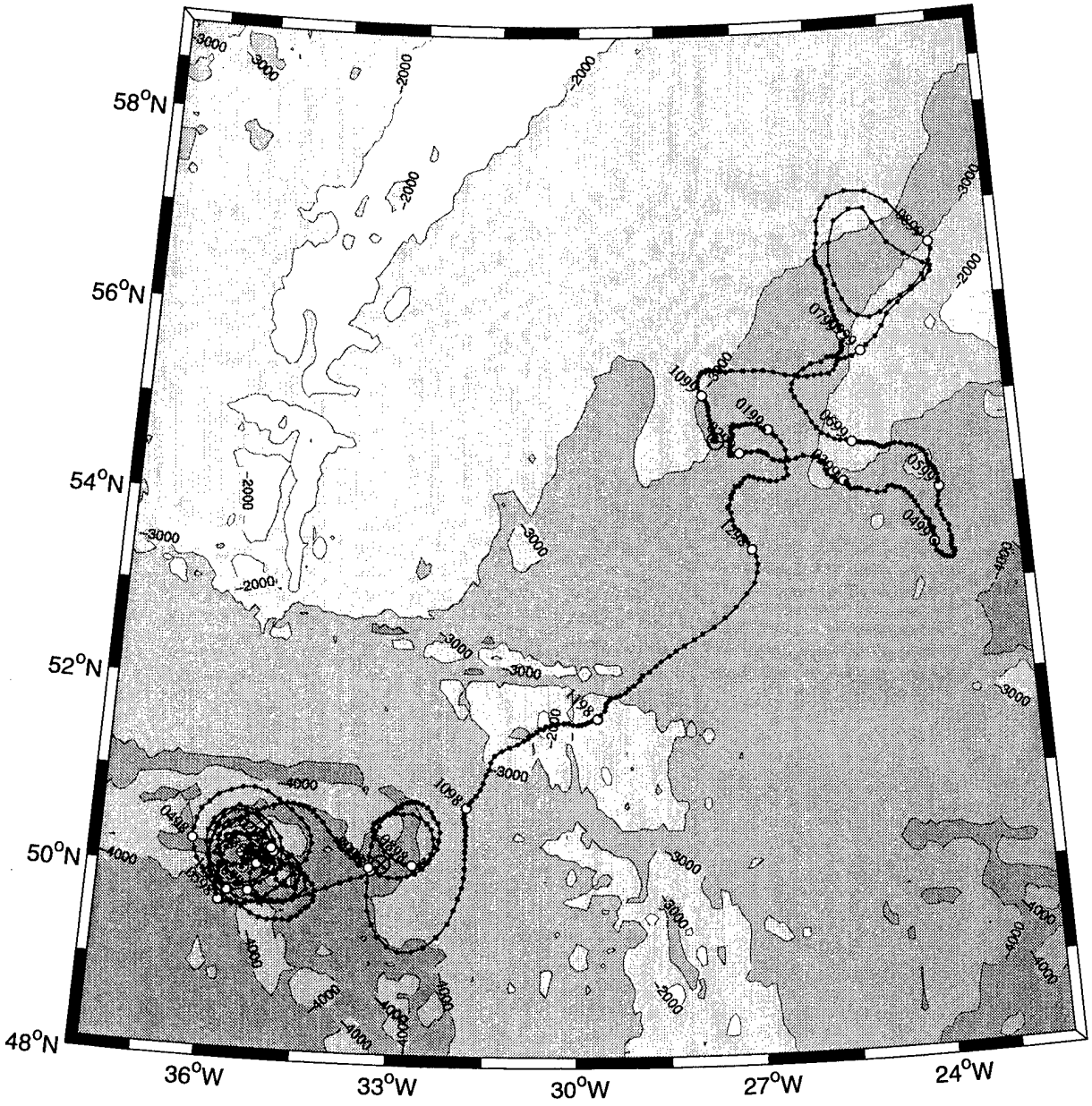
w389: 100% msgs, 15-day interp

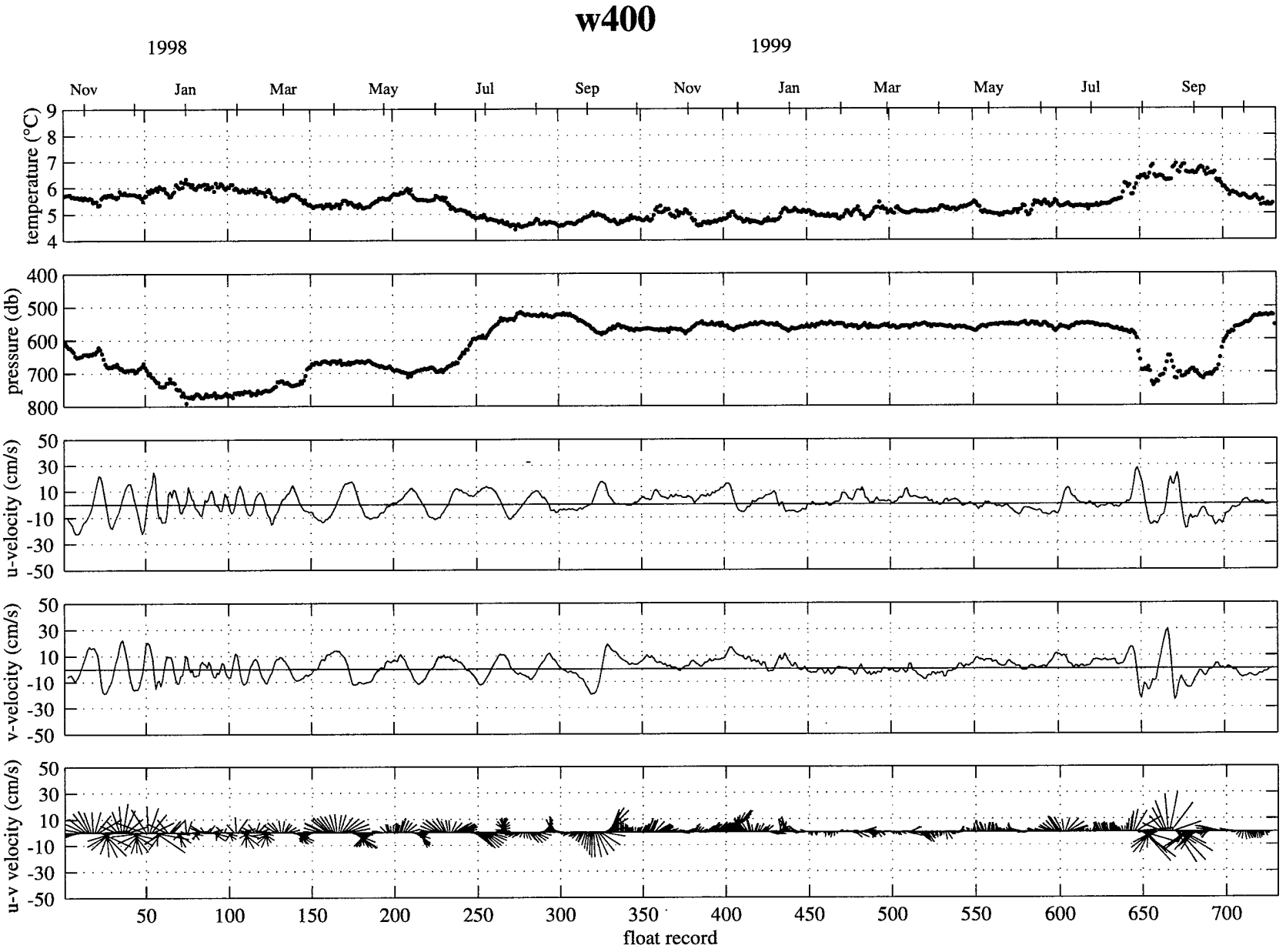


w389

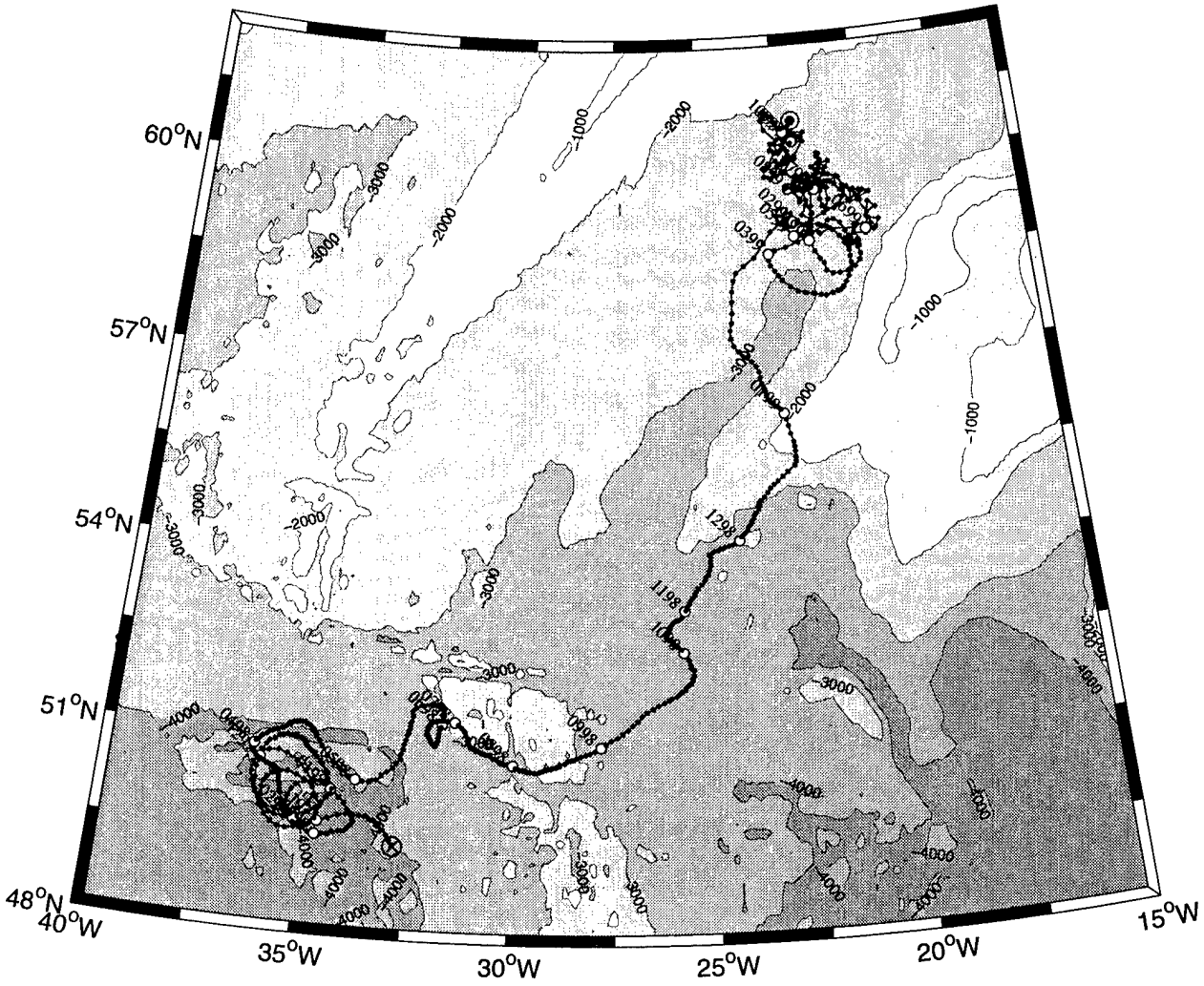

1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
8
7
6
5
4
3
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w400: 94% msgs, 10–day interp

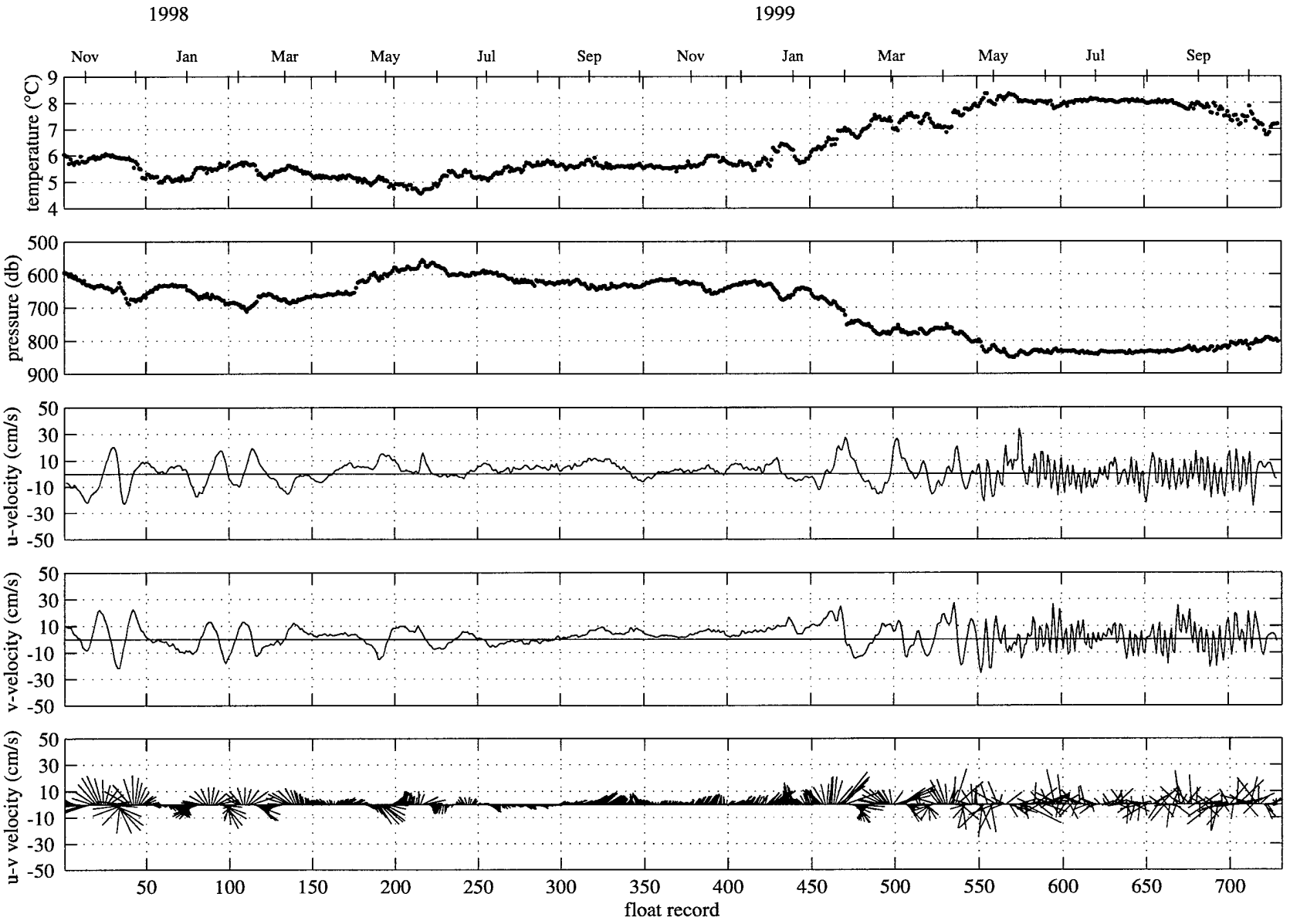



w400
1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
9
8
7
6
5
4
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

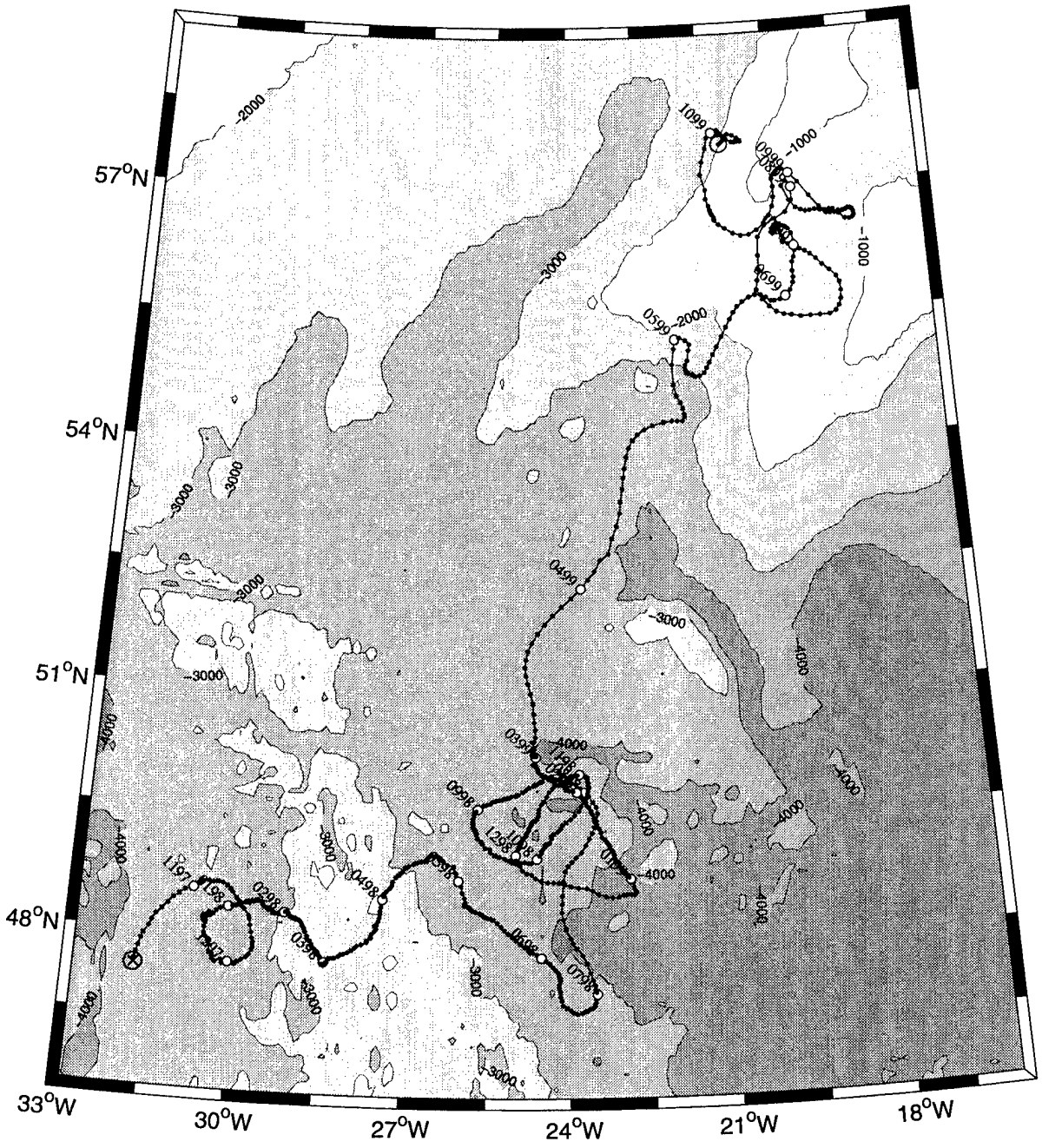
w413: 93% msgs, 10–day interp



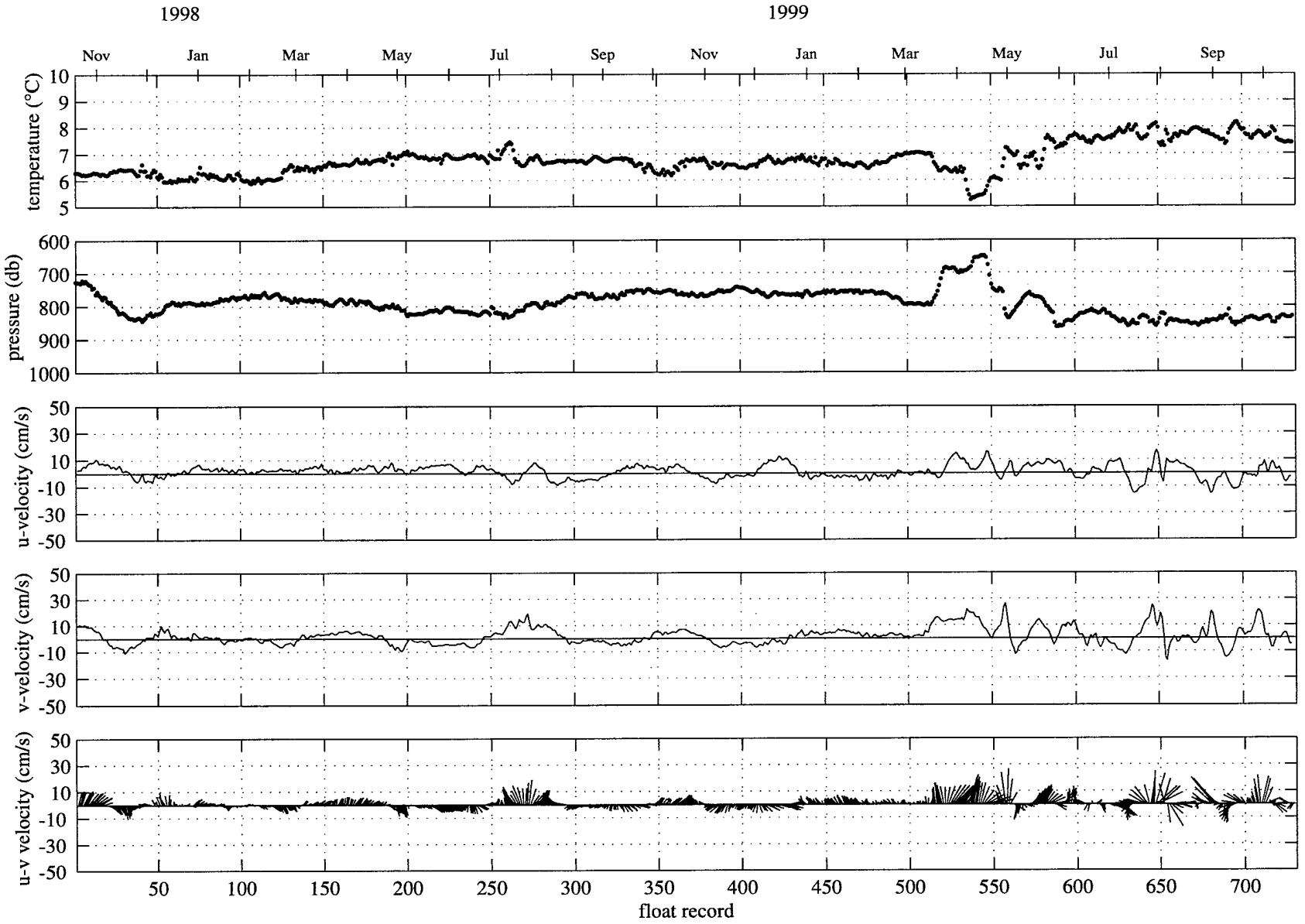
w413


1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
9
8
7
6
5
4
pressure (db)
500
600
700
800
900
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

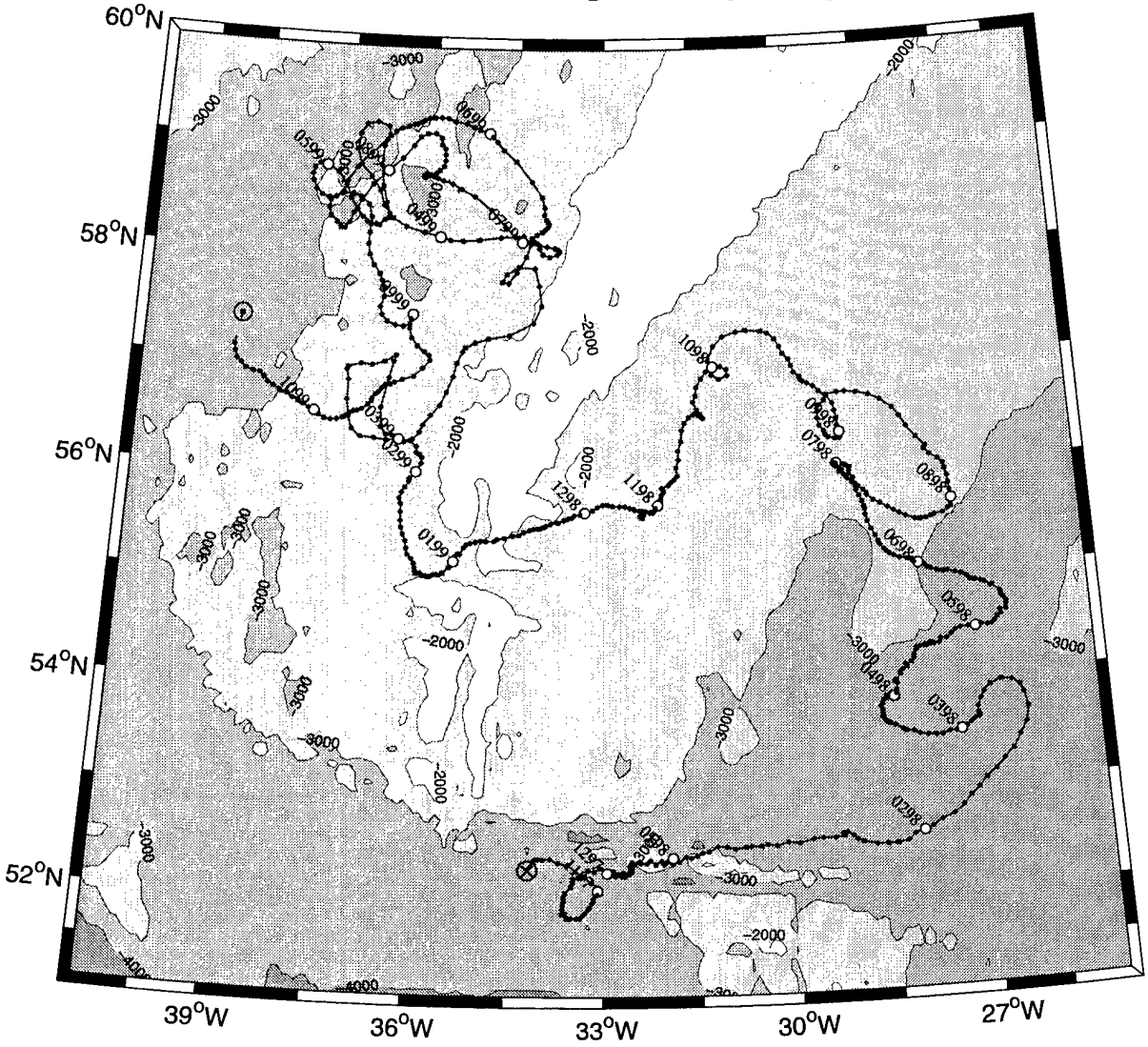
w414: 80% msgs, 20–day interp



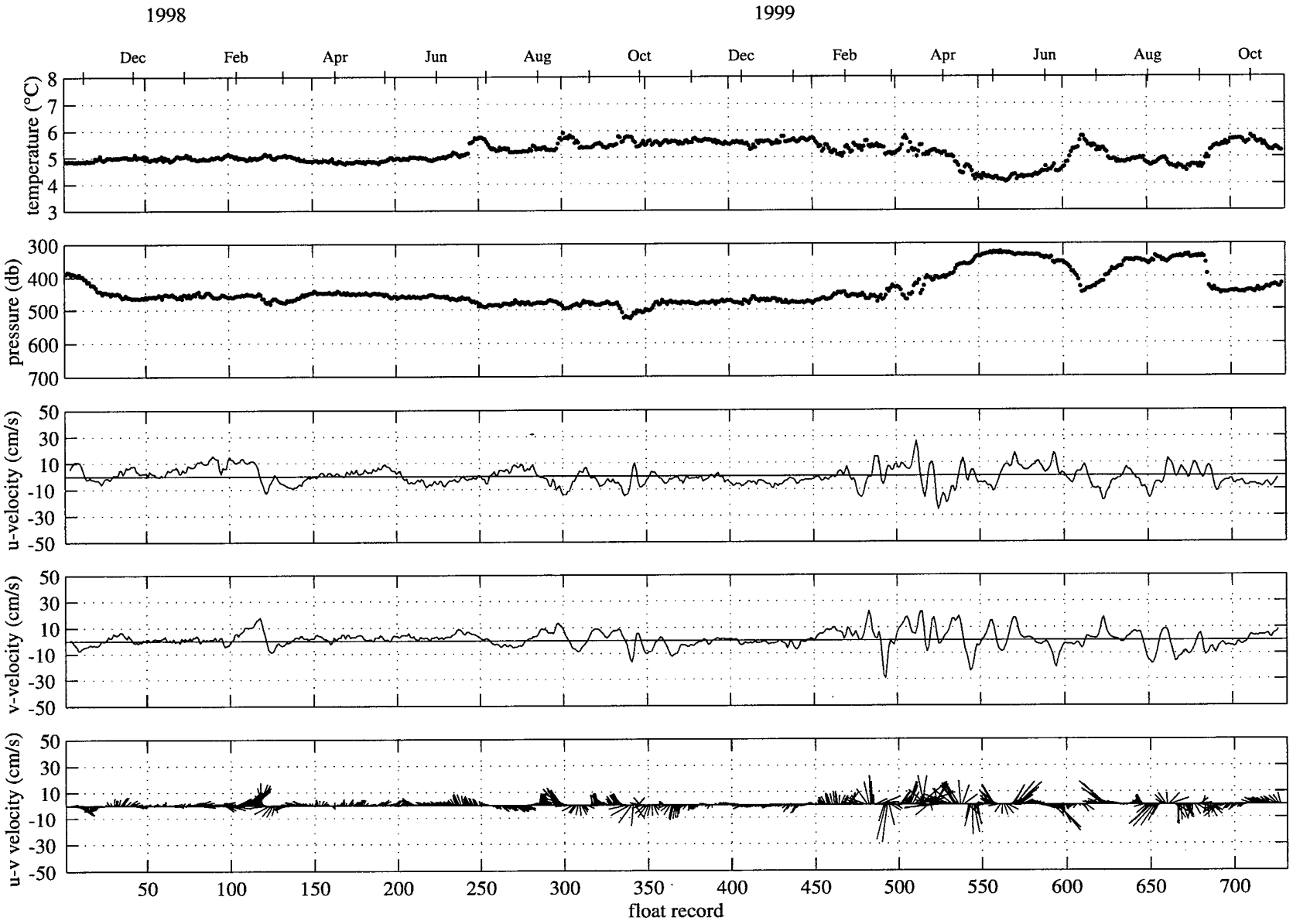
w414


1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
10
9
8
7
6
5
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

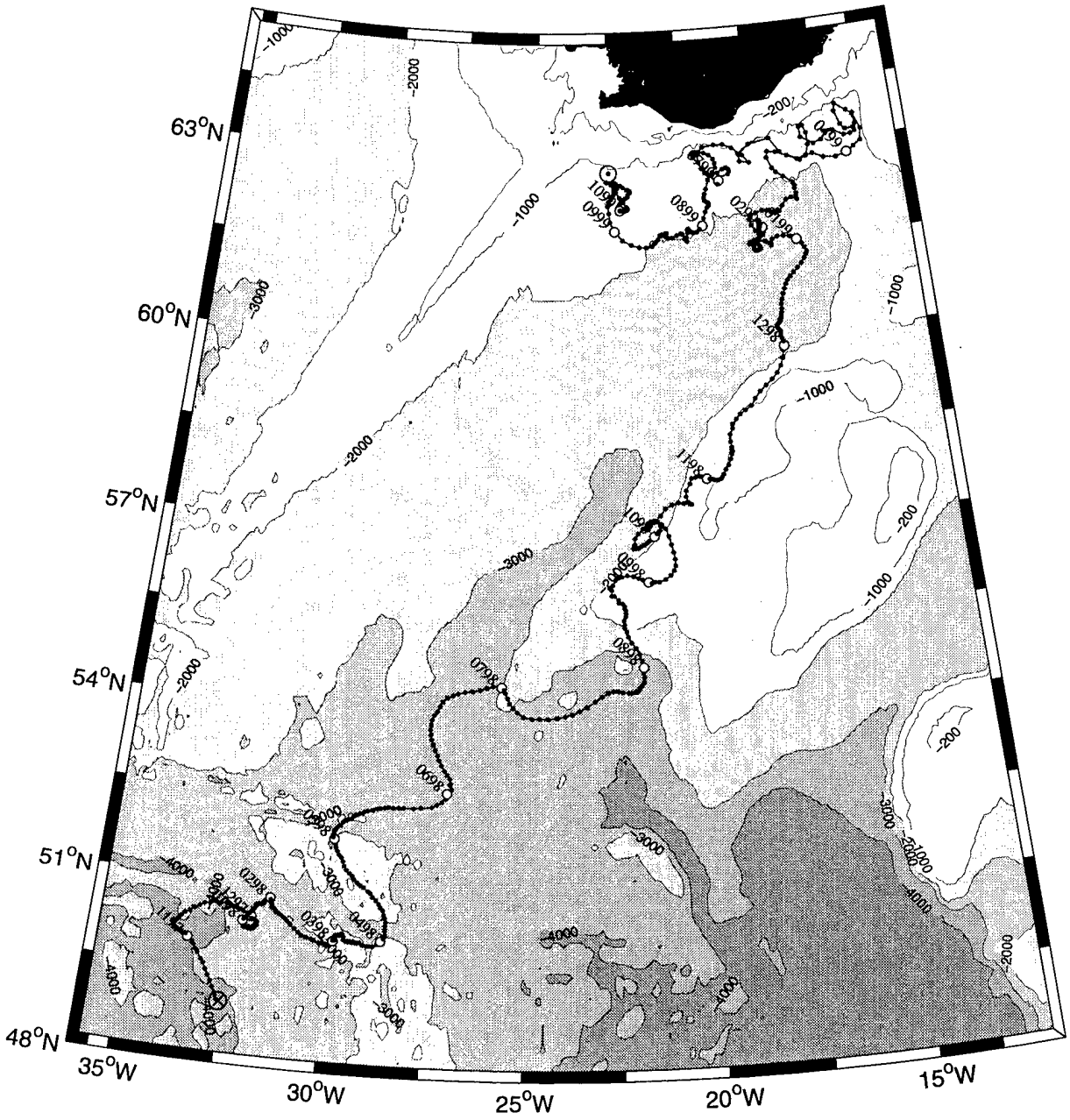
w415: 97% msgs, 10–day interp

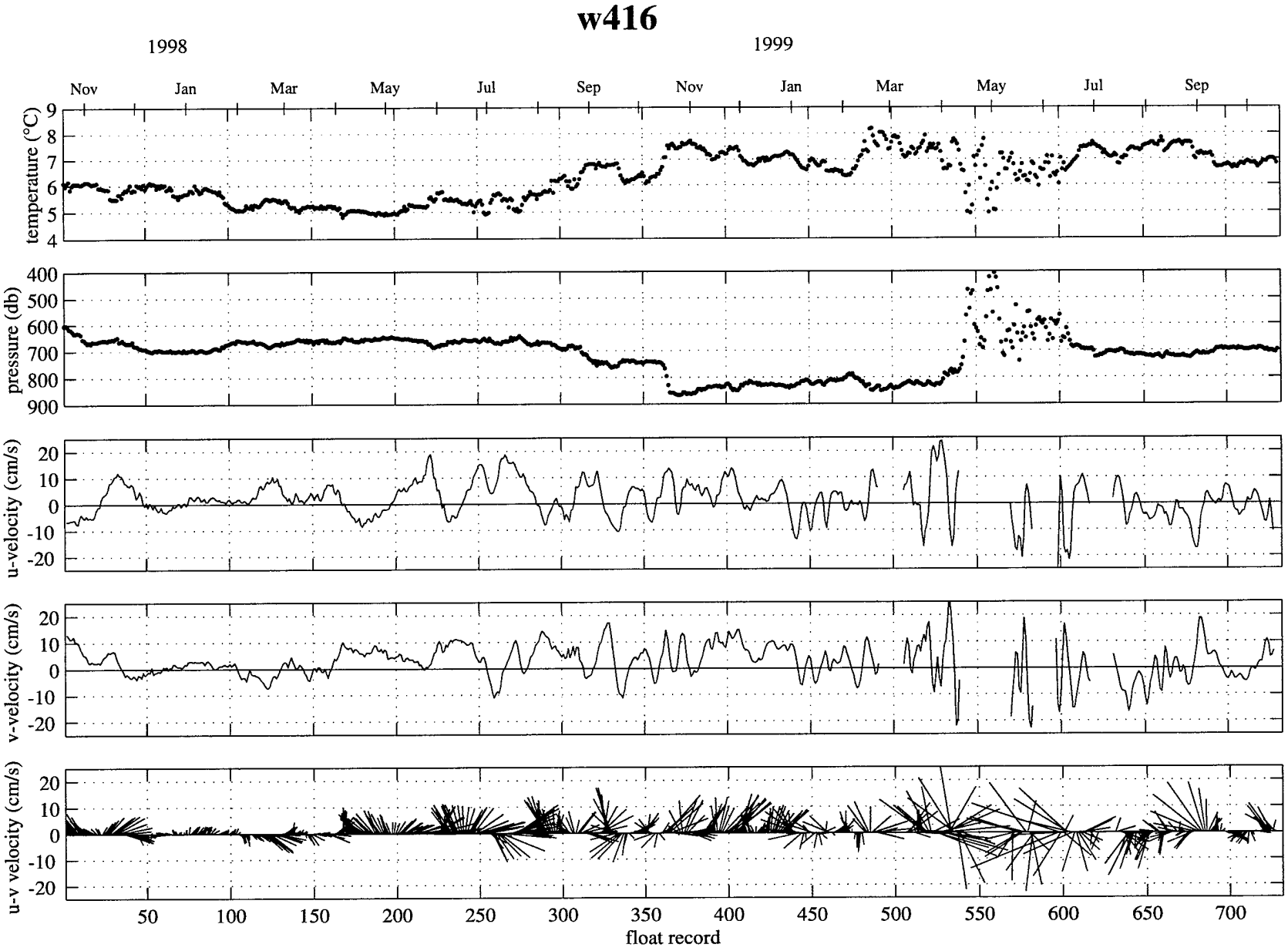


w415

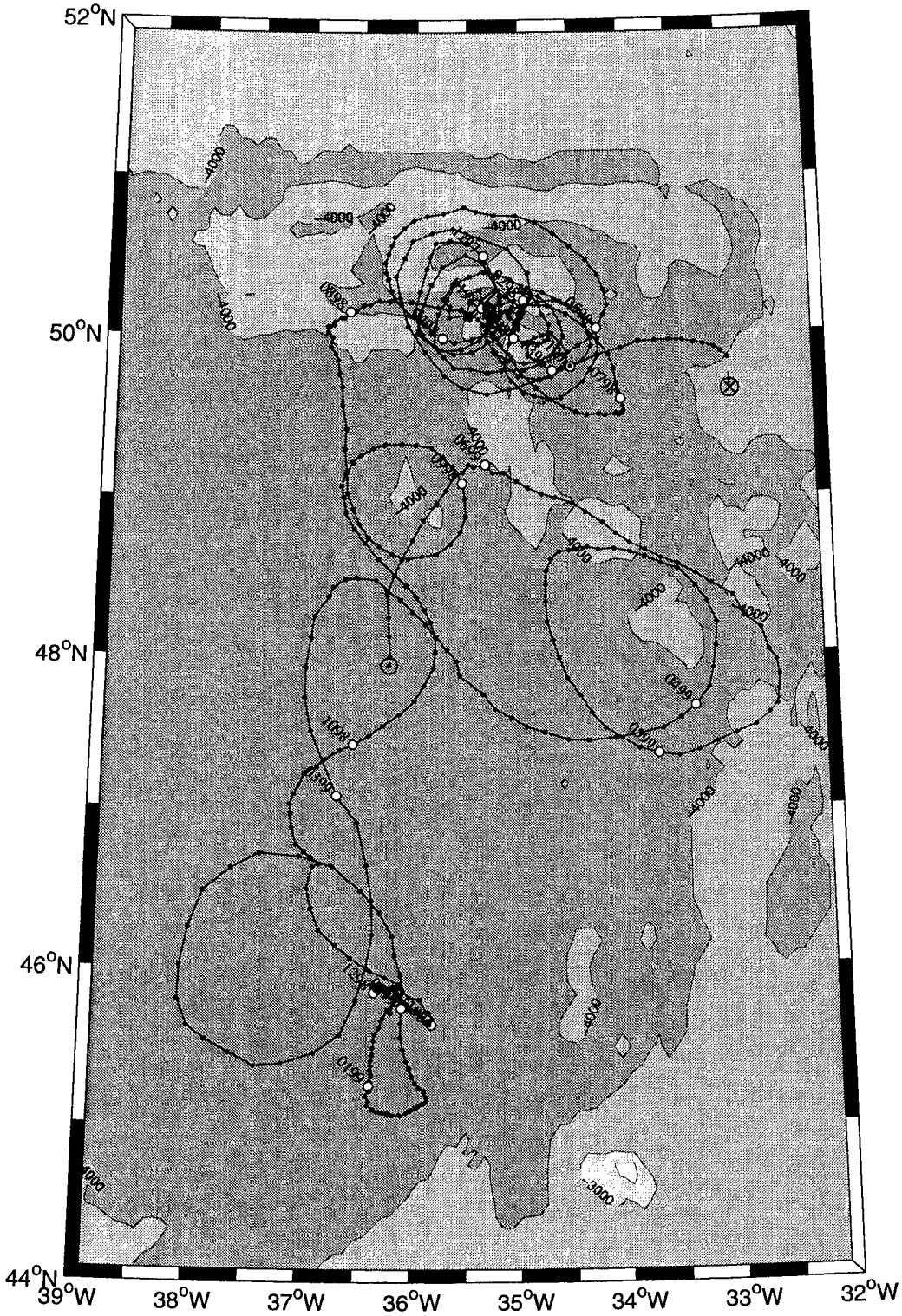

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
8
7
6
5
4
3
pressure (db)
300
400
500
600
700
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

w416: 94% msgs, 20–day interp

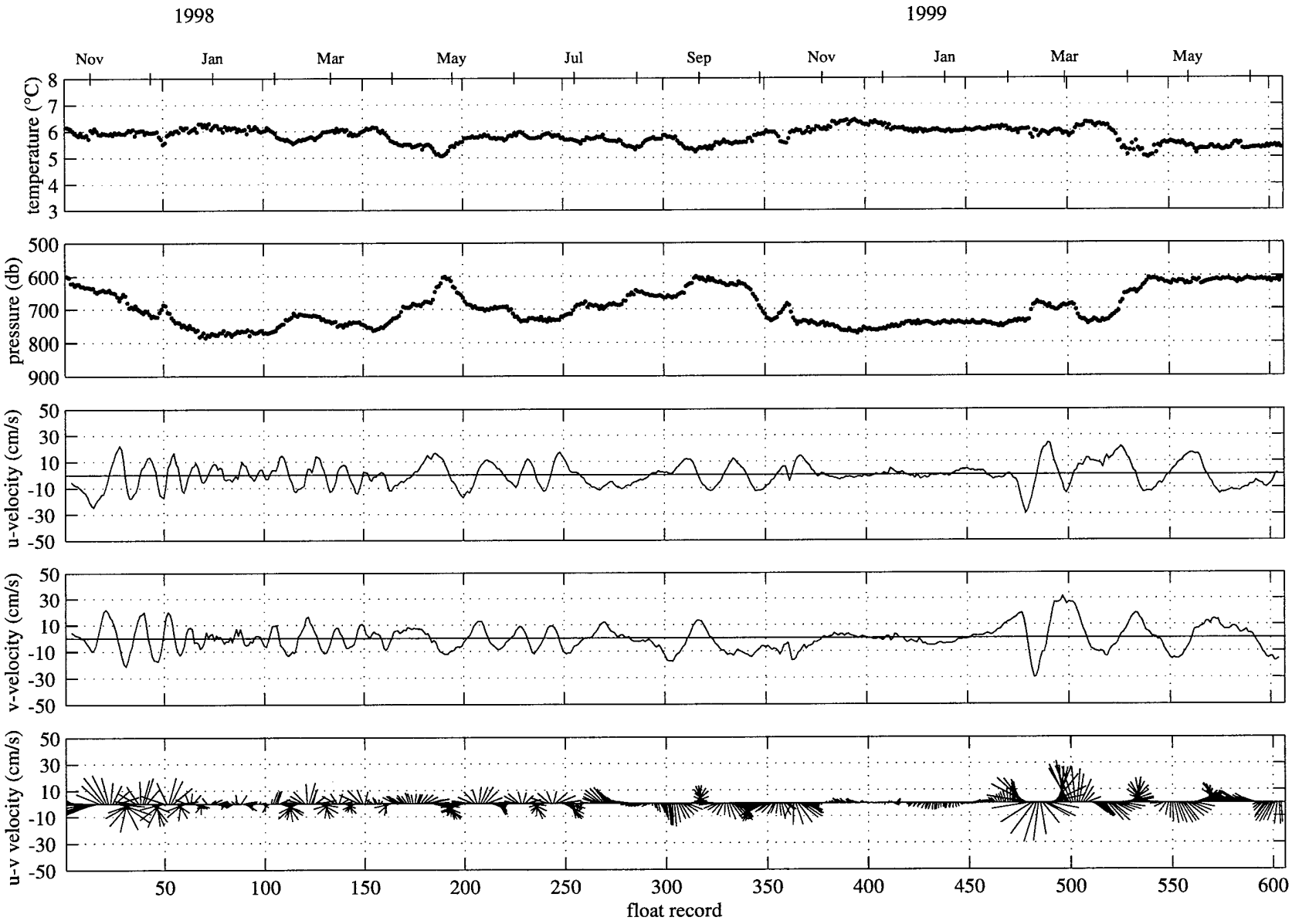



w416
1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
pressure (db)
u-velocity (cm/s)
v-velocity (cm/s)
u-v velocity (cm/s)
float record

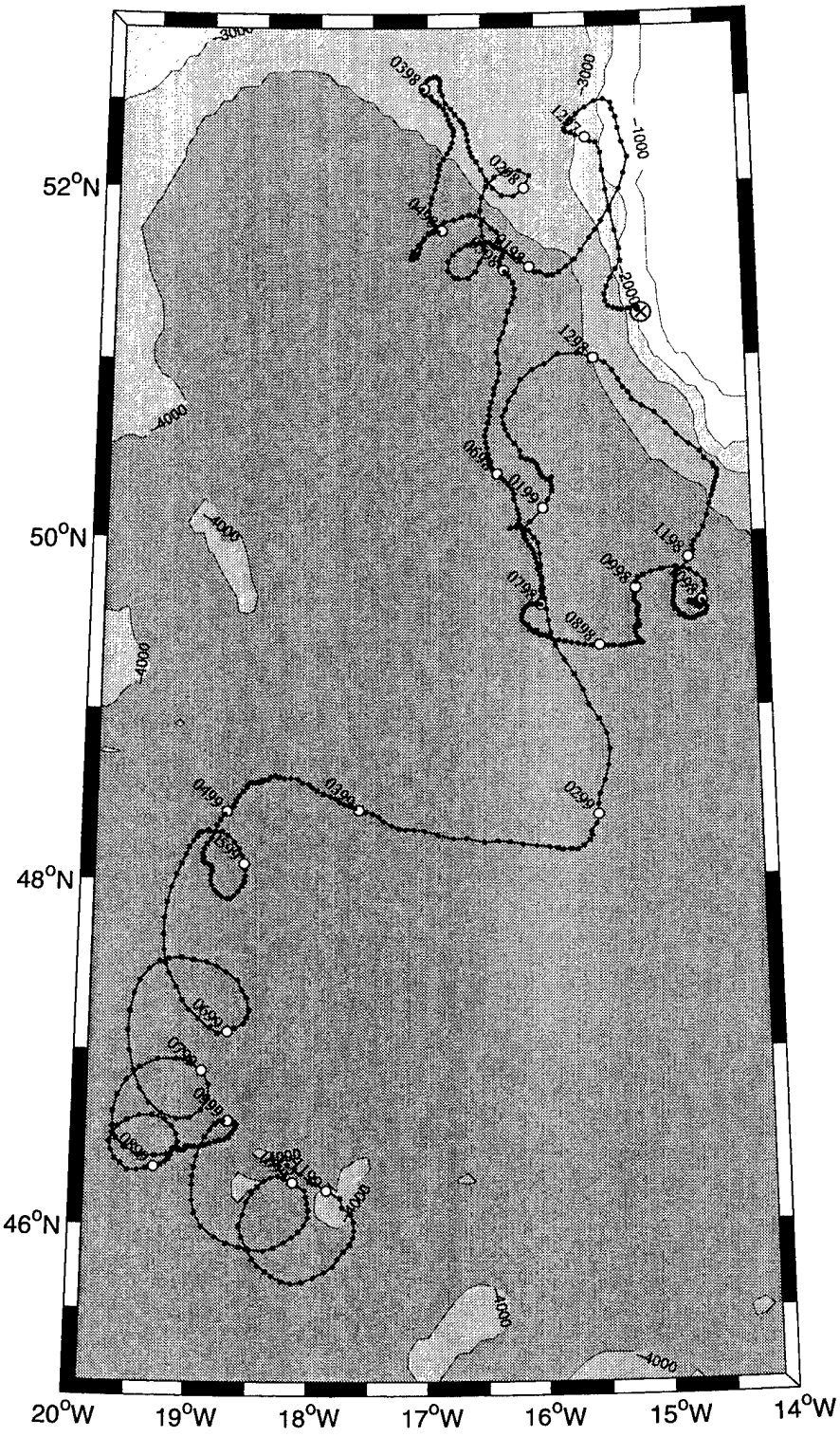
w418: 96% msgs, 10–day interp



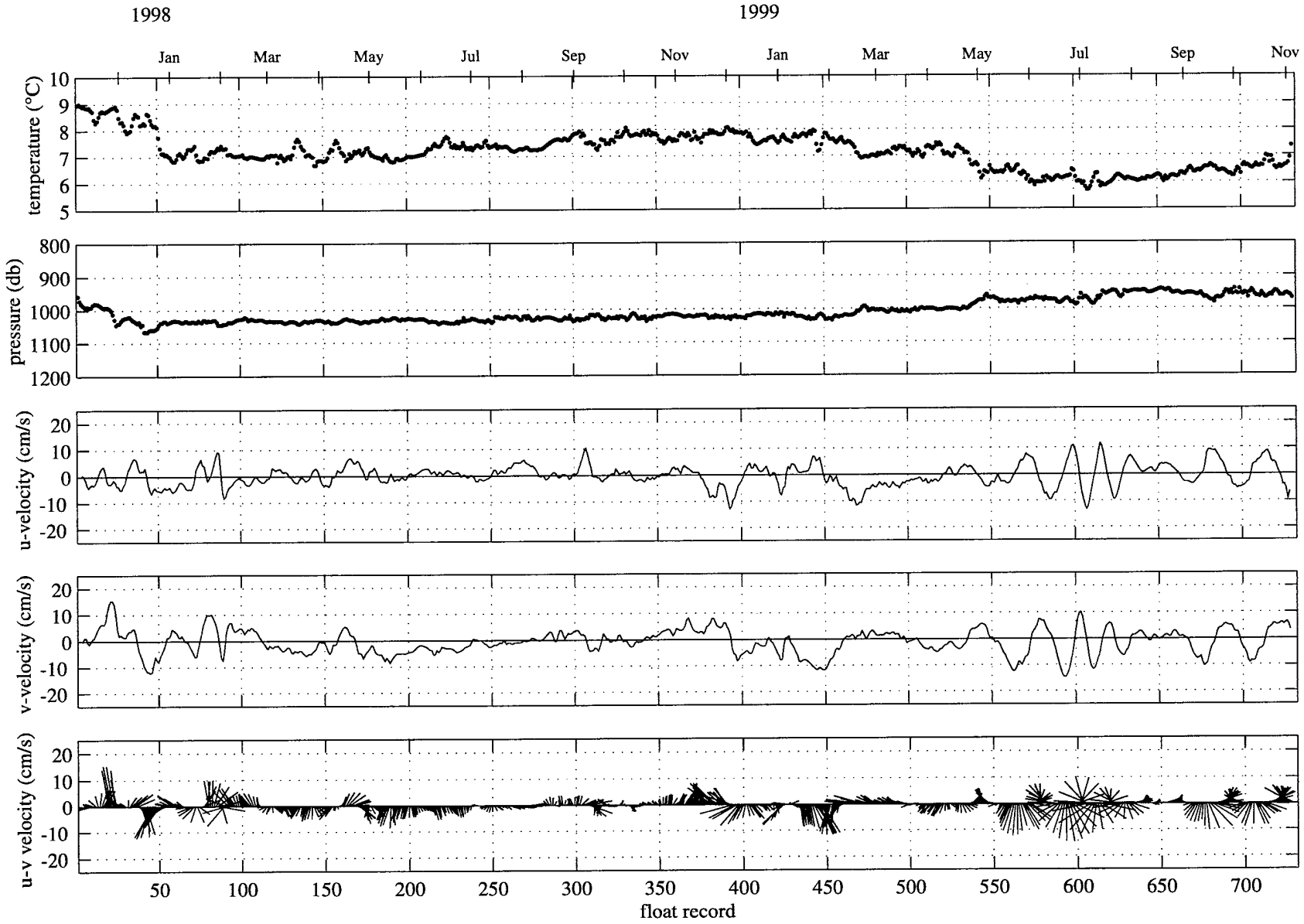
w418

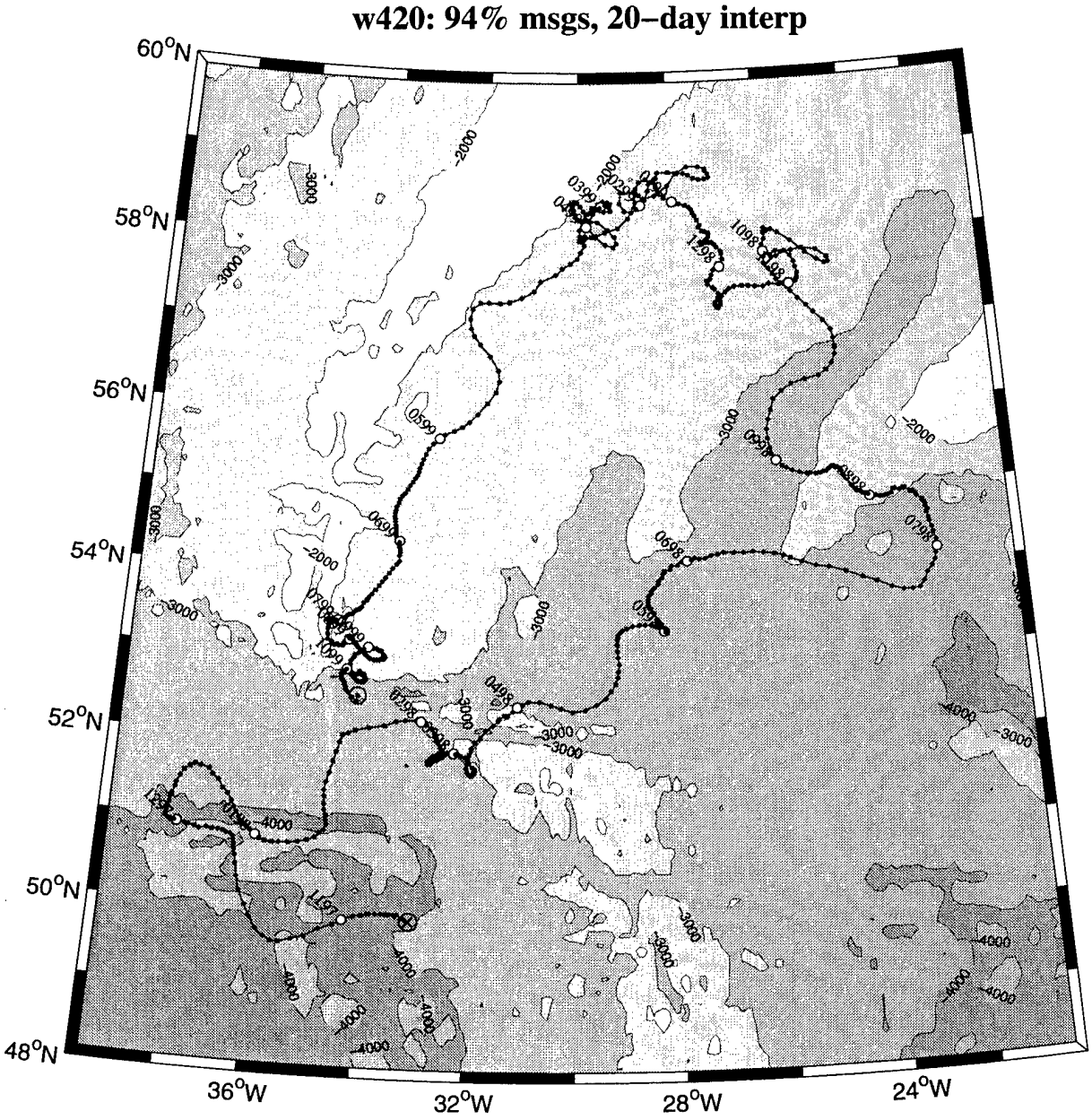

1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
temperature (°C)
8
7
6
5
4
3
pressure (db)
500
600
700
800
900
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
float record

w419: 72% msgs, 10–day interp

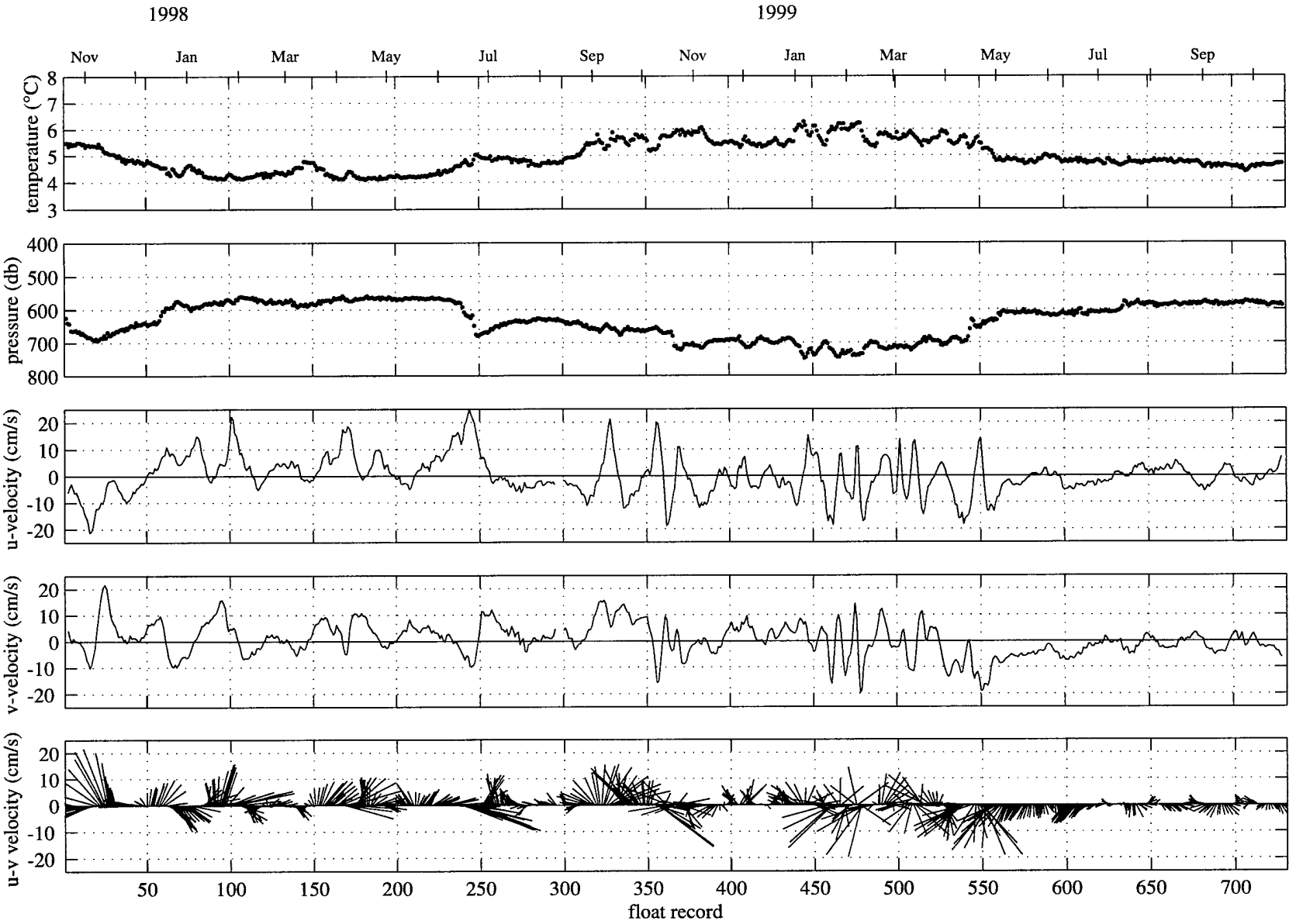


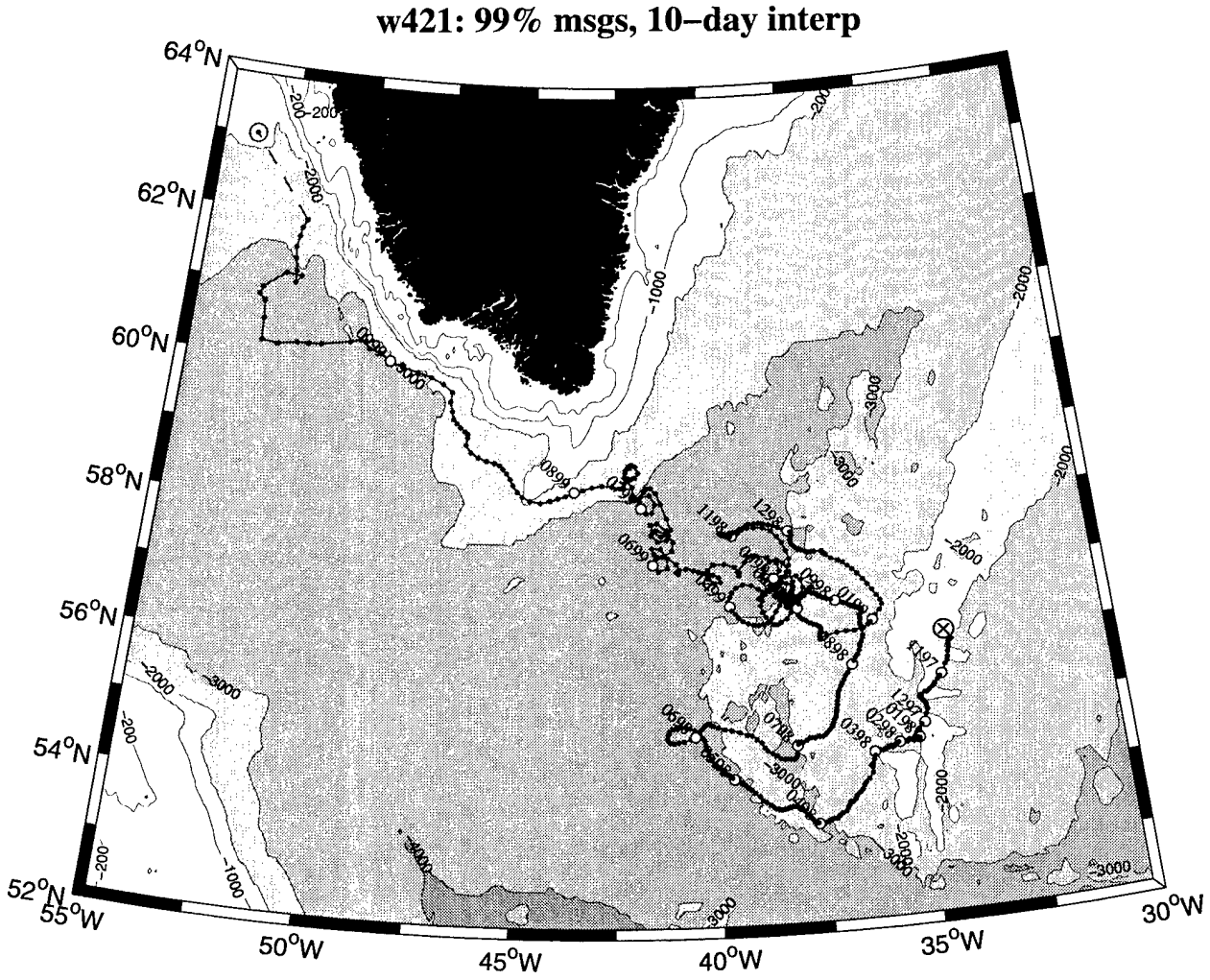
w419


1998
1999
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
temperature (°C)
10
9
8
7
6
5
pressure (db)
800
900
1000
1100
1200
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

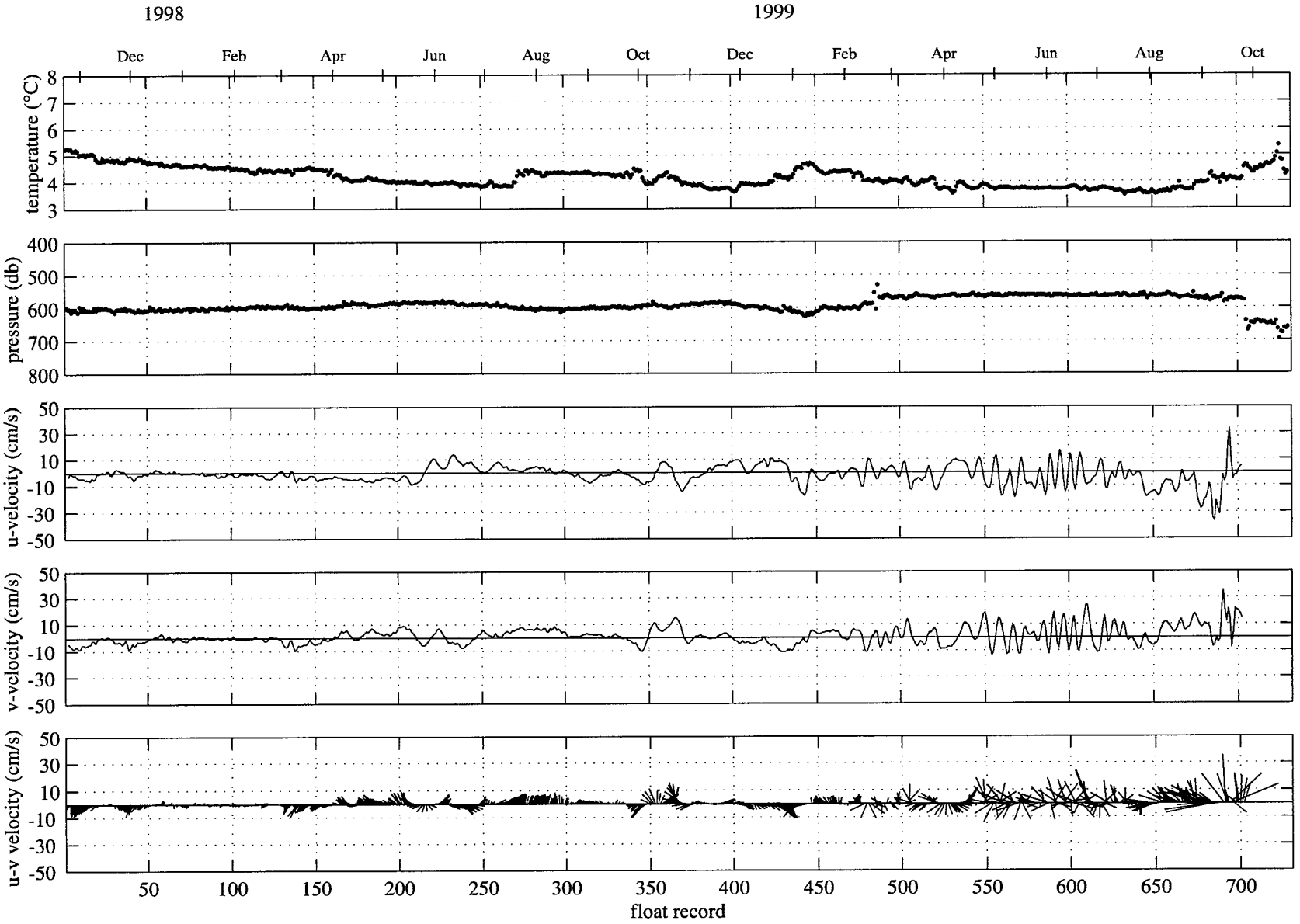

w420: 94% msgs, 20–day interp
60°N
58°N
56°N
54°N
52°N
50°N
48°N
36°W
32°W
28°W
24°W

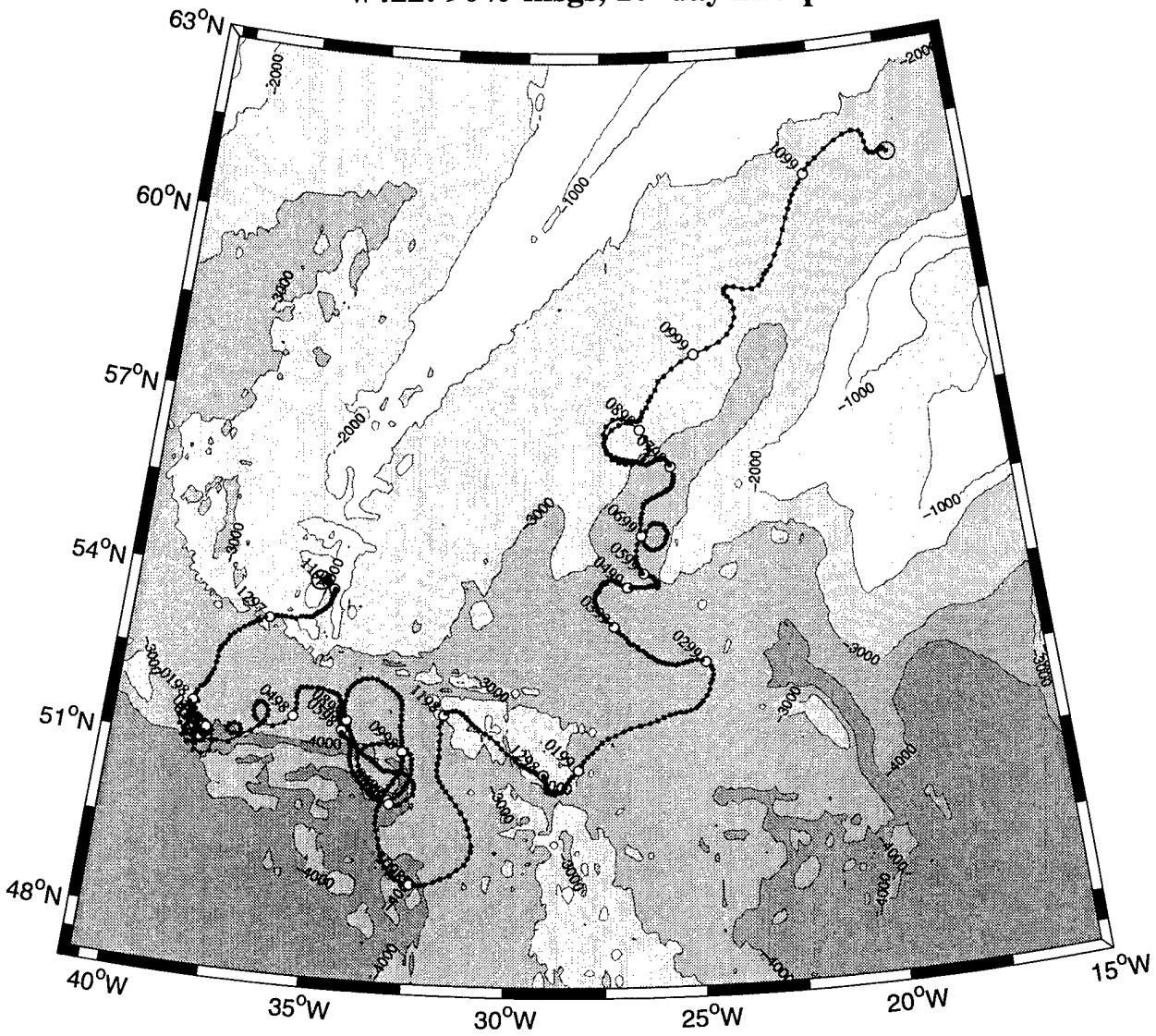
w420


1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
8
7
6
5
4
3
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

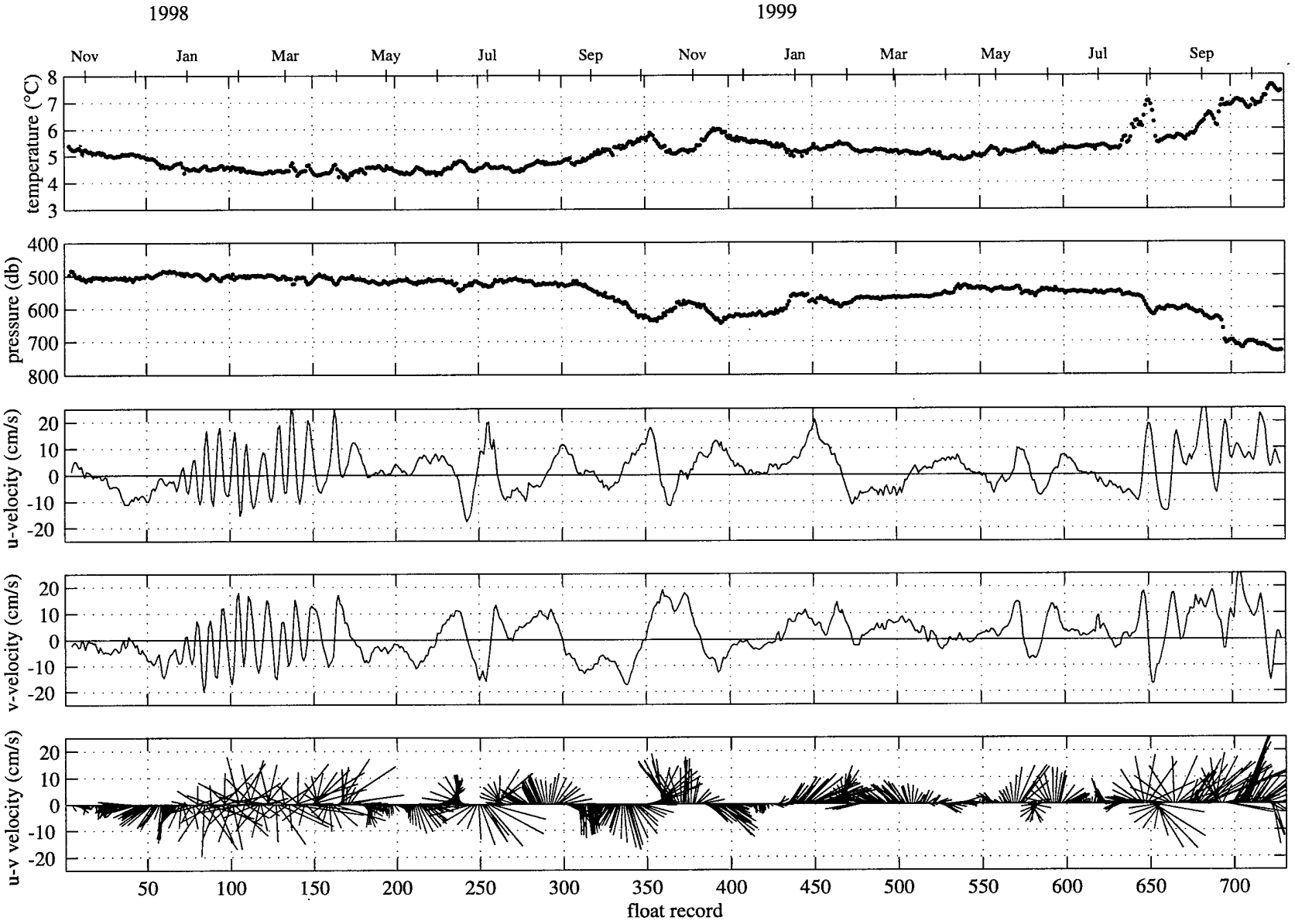

w421: 99% msgs, 10–day interp
64°N
62°N
60°N
58°N
56°N
54°N
52°N
55°W
50°W
45°W
40°W
35°W
30°W

w421

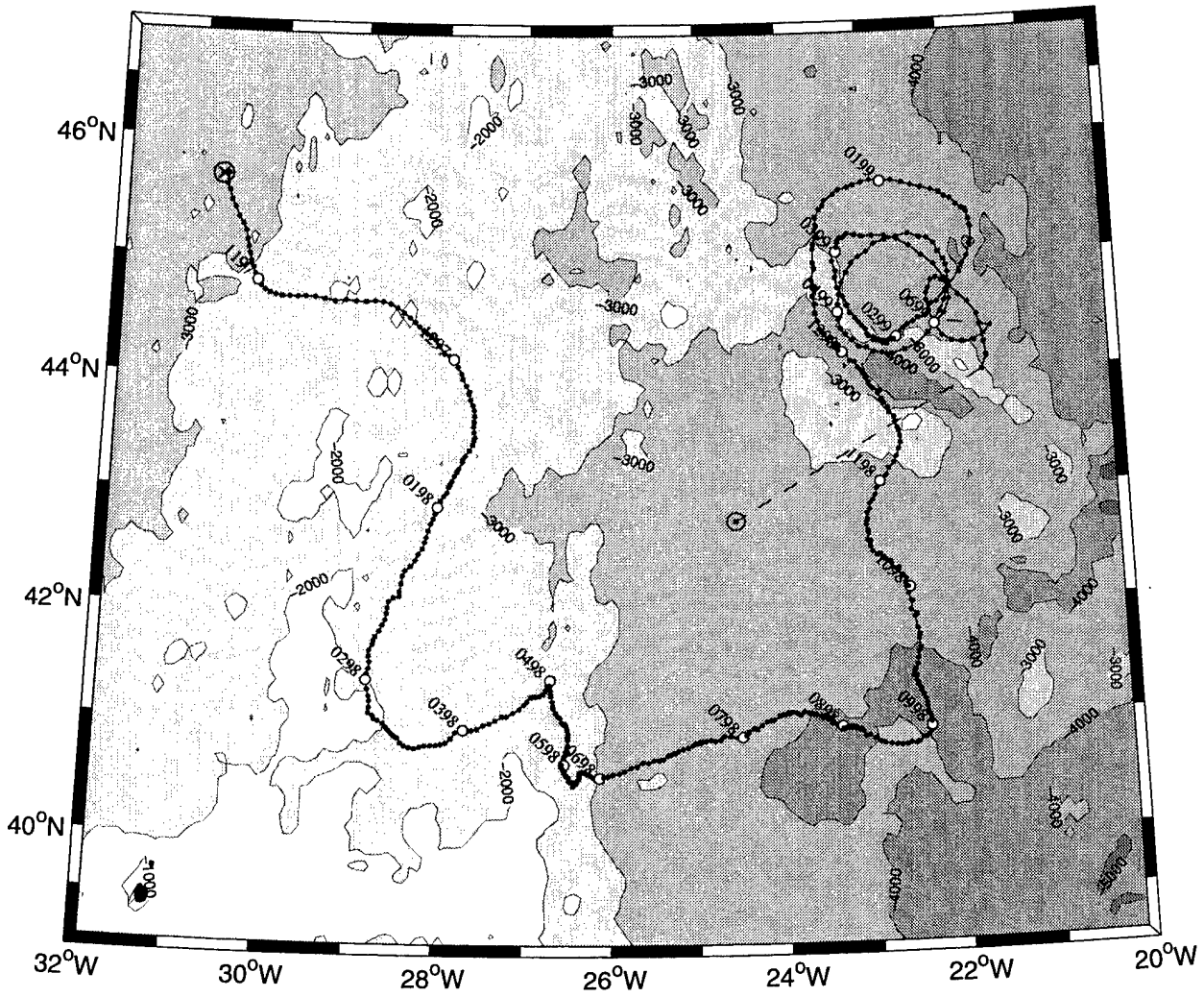

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
8
7
6
5
4
3
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record


w422: 90% msgs, 10–day interp
63°N
60°N
57°N
54°N
51°N
48°N
40°W
35°W
30°W
25°W
20°W
15°W

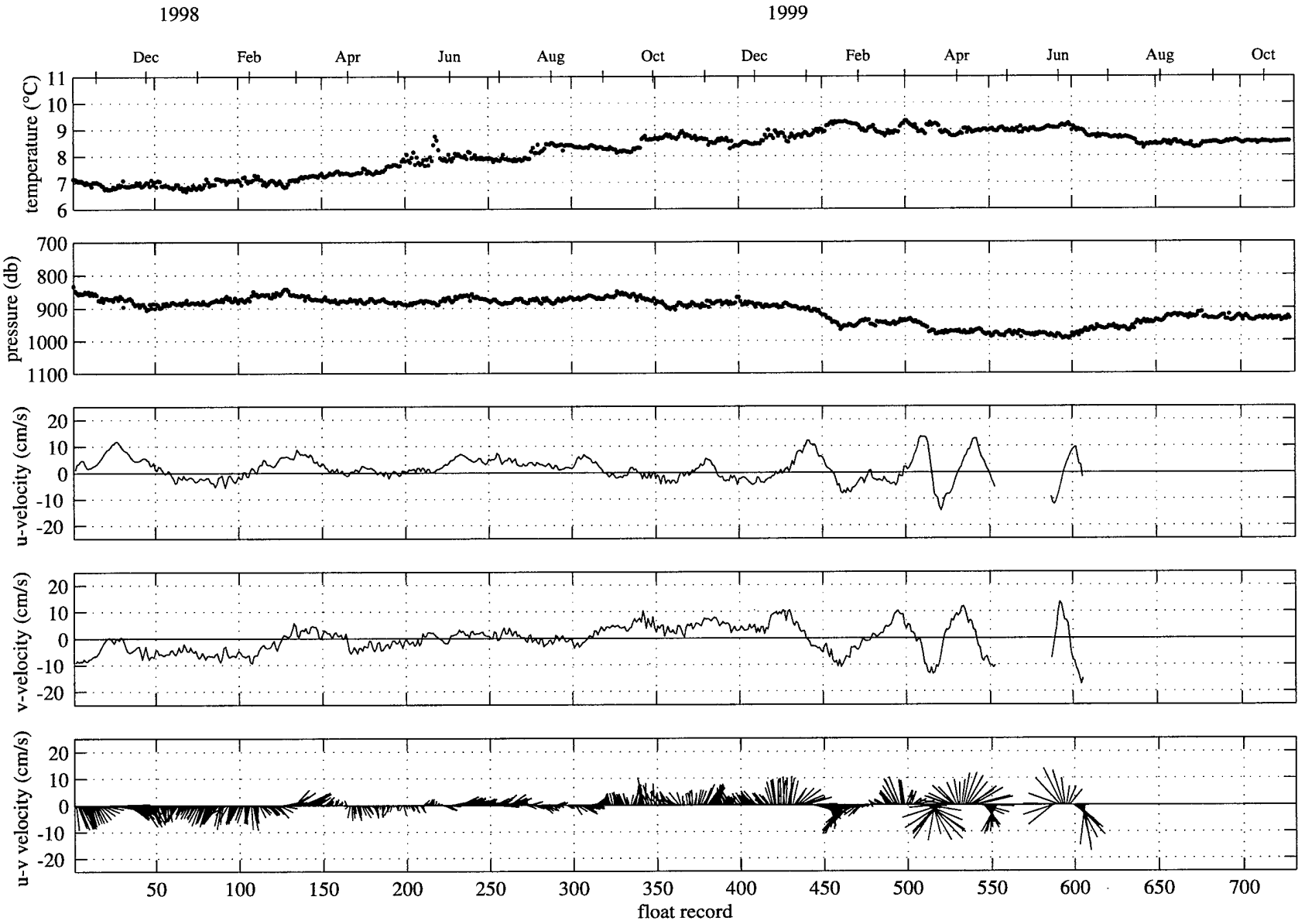
w422


1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
8
7
6
5
4
3
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

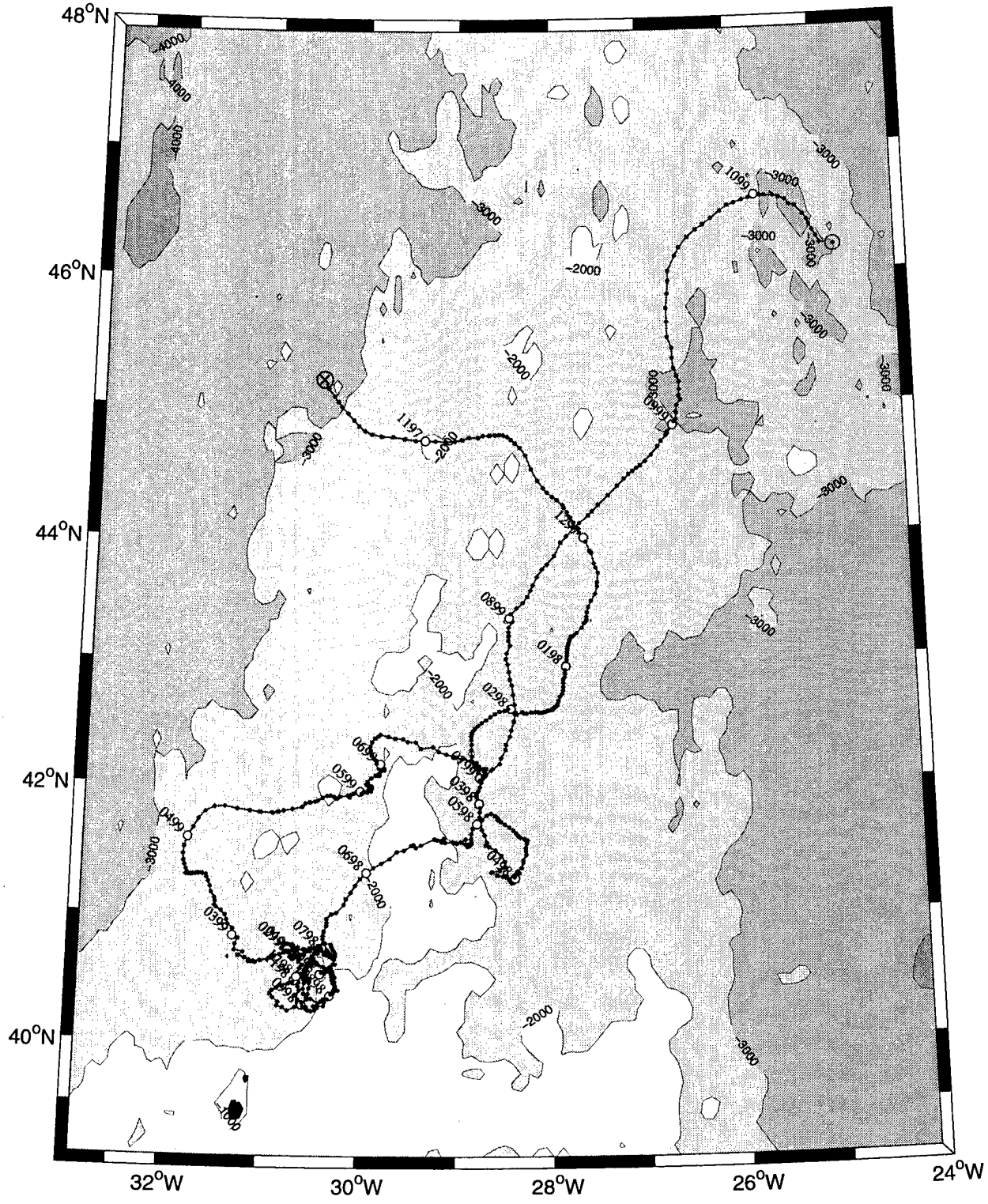
w423: 90% msgs, 20–day interp



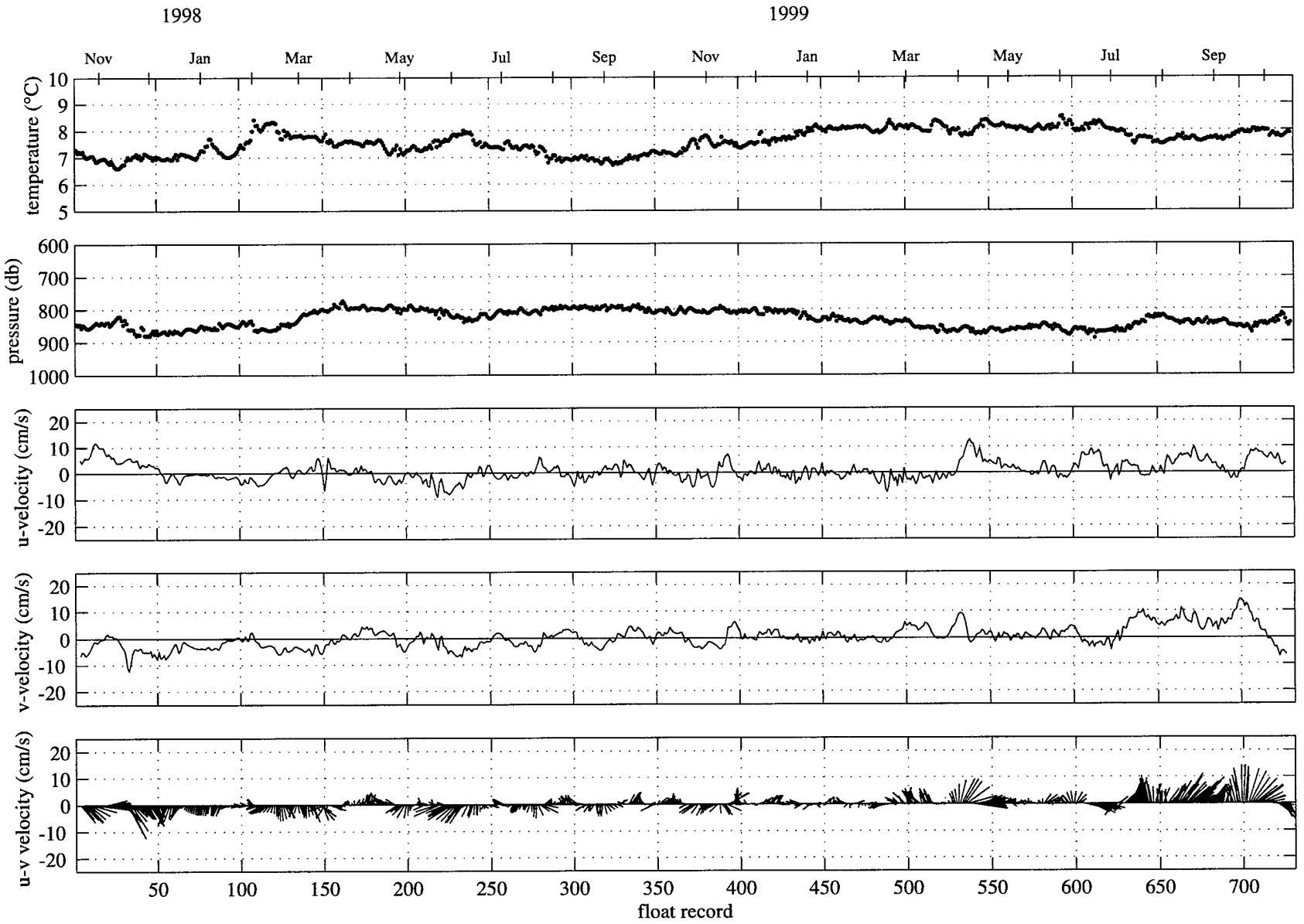
w423


1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
11
10
9
8
7
6
pressure (db)
700
800
900
1000
1100
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

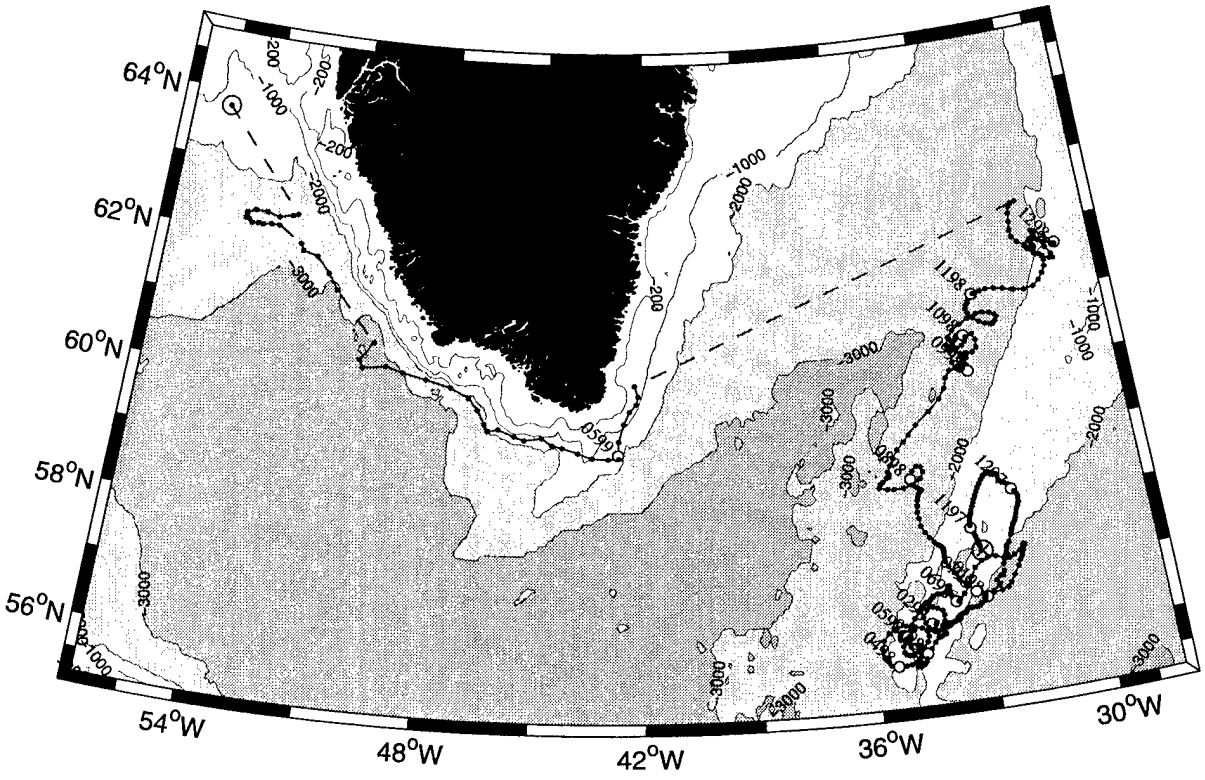
w424: 75% msgs, 15–day interp



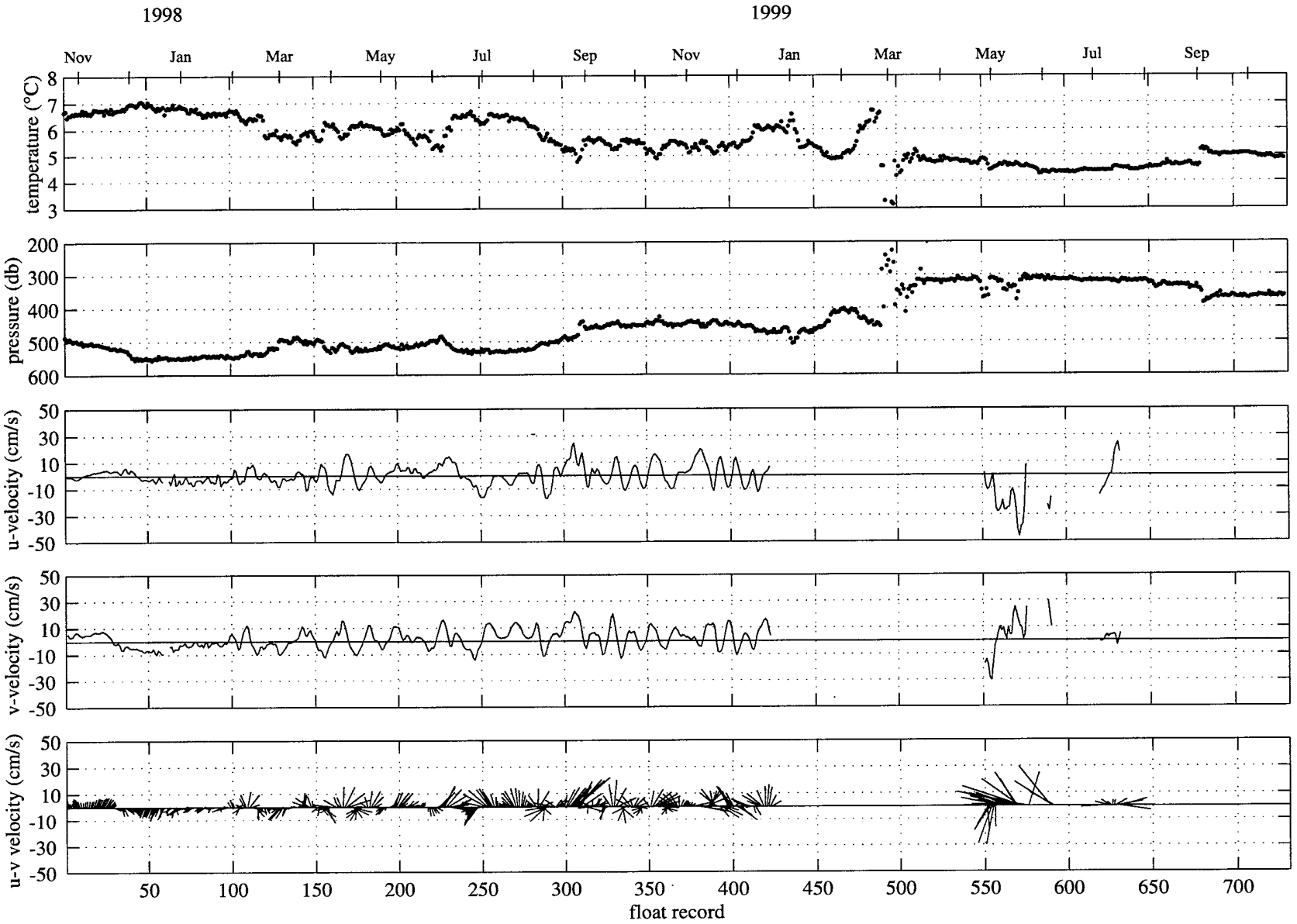
w424


1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
10
9
8
7
6
5
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

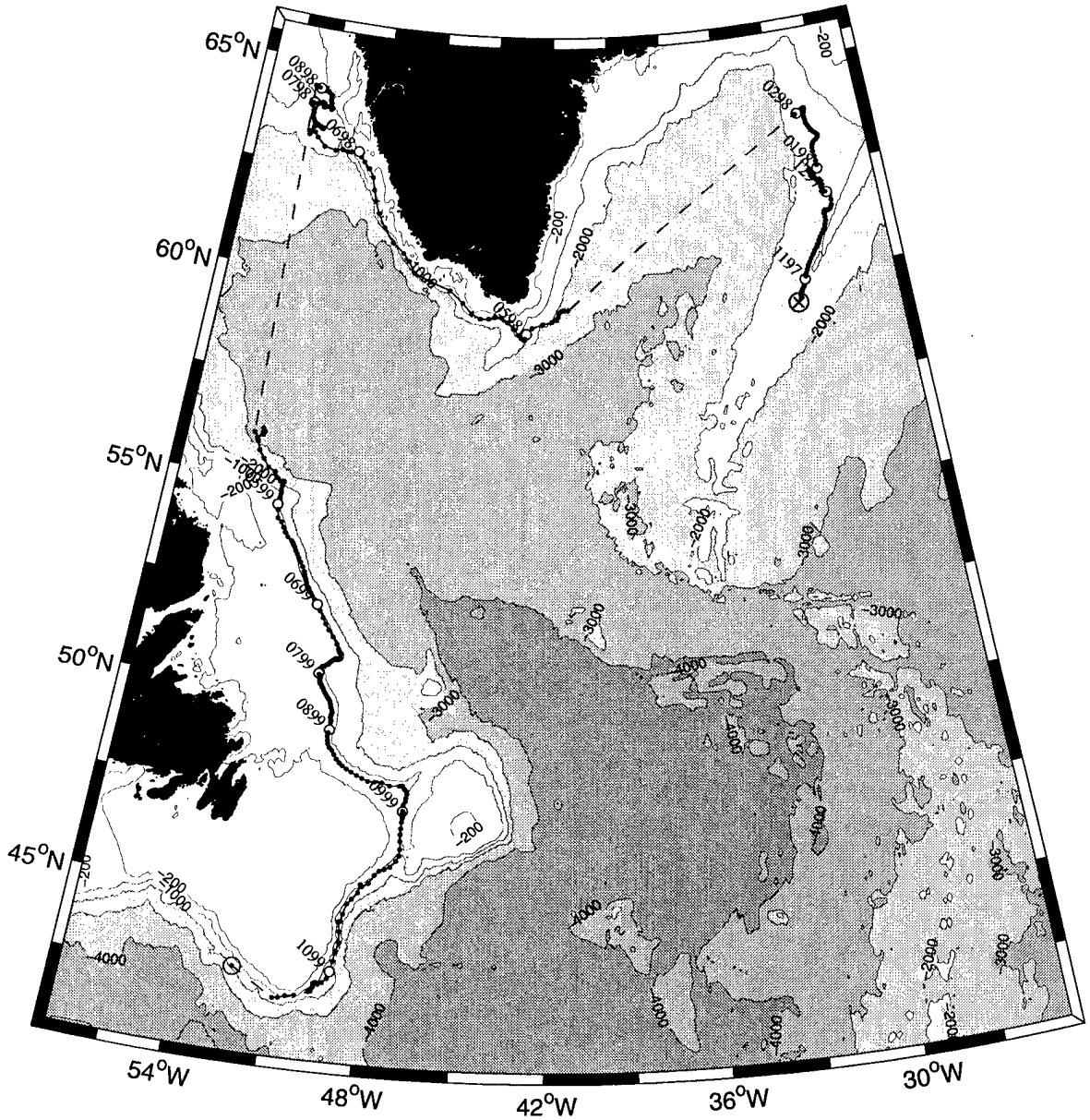
w425: 100% msgs, 20-day interp



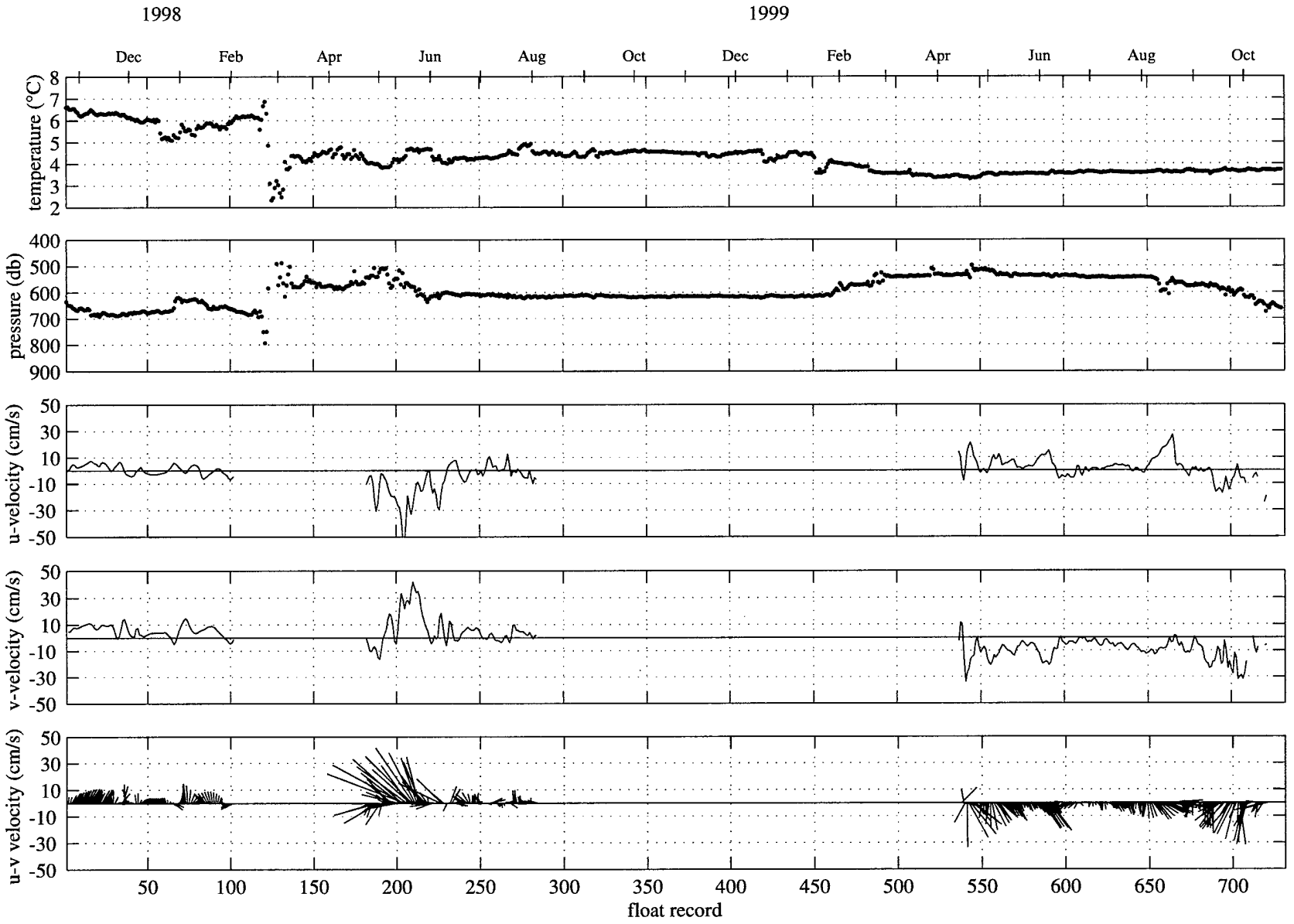
w425


1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
8
7
6
5
4
3
pressure (db)
200
300
400
500
600
u-velocity (cm/s)
50
30
10
-10
-30
-50
v-velocity (cm/s)
50
30
10
-10
-30
-50
u-v velocity (cm/s)
50
30
10
-10
-30
-50
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

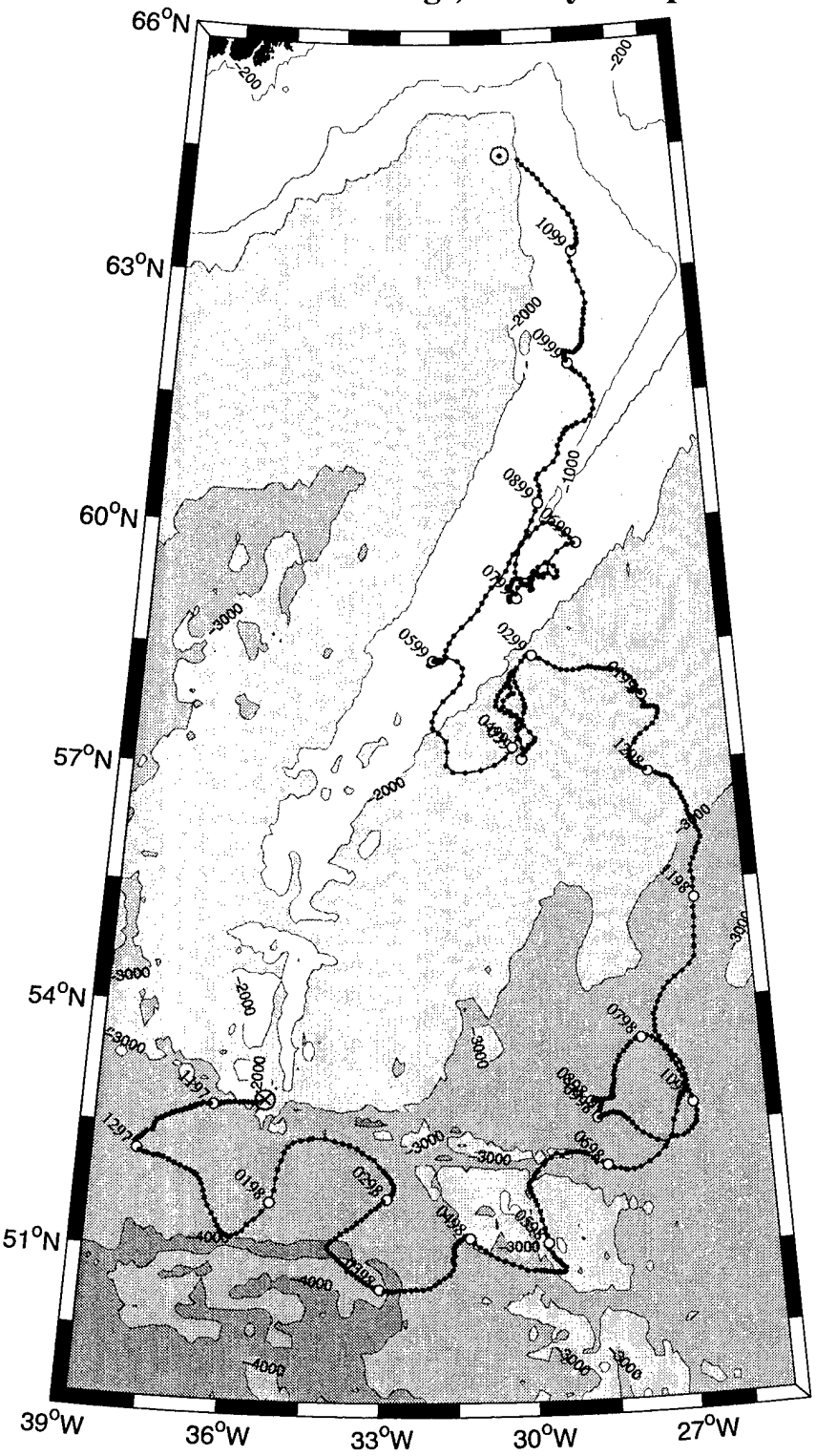
w426: 90% msgs, 20–day interp

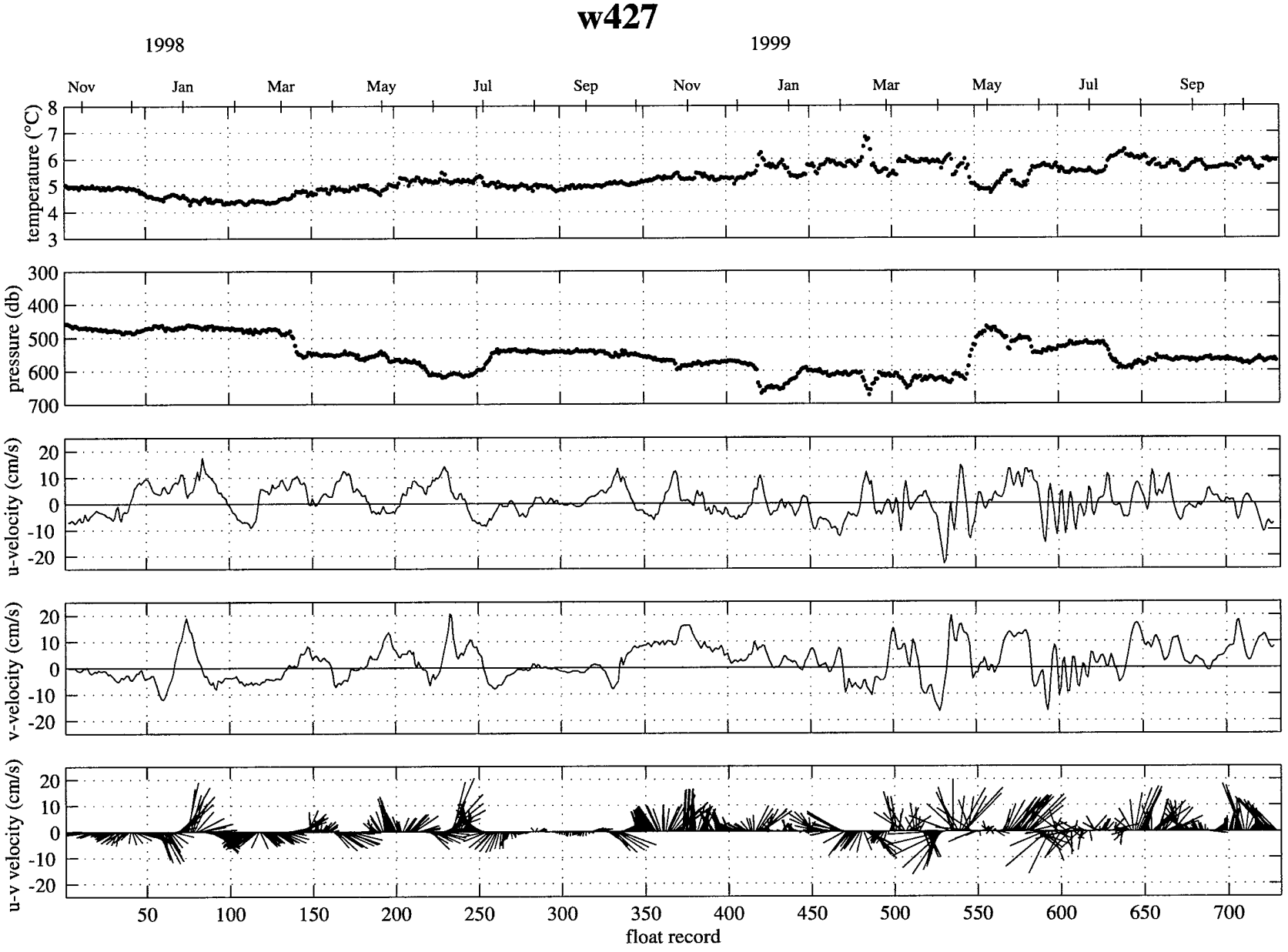


w426

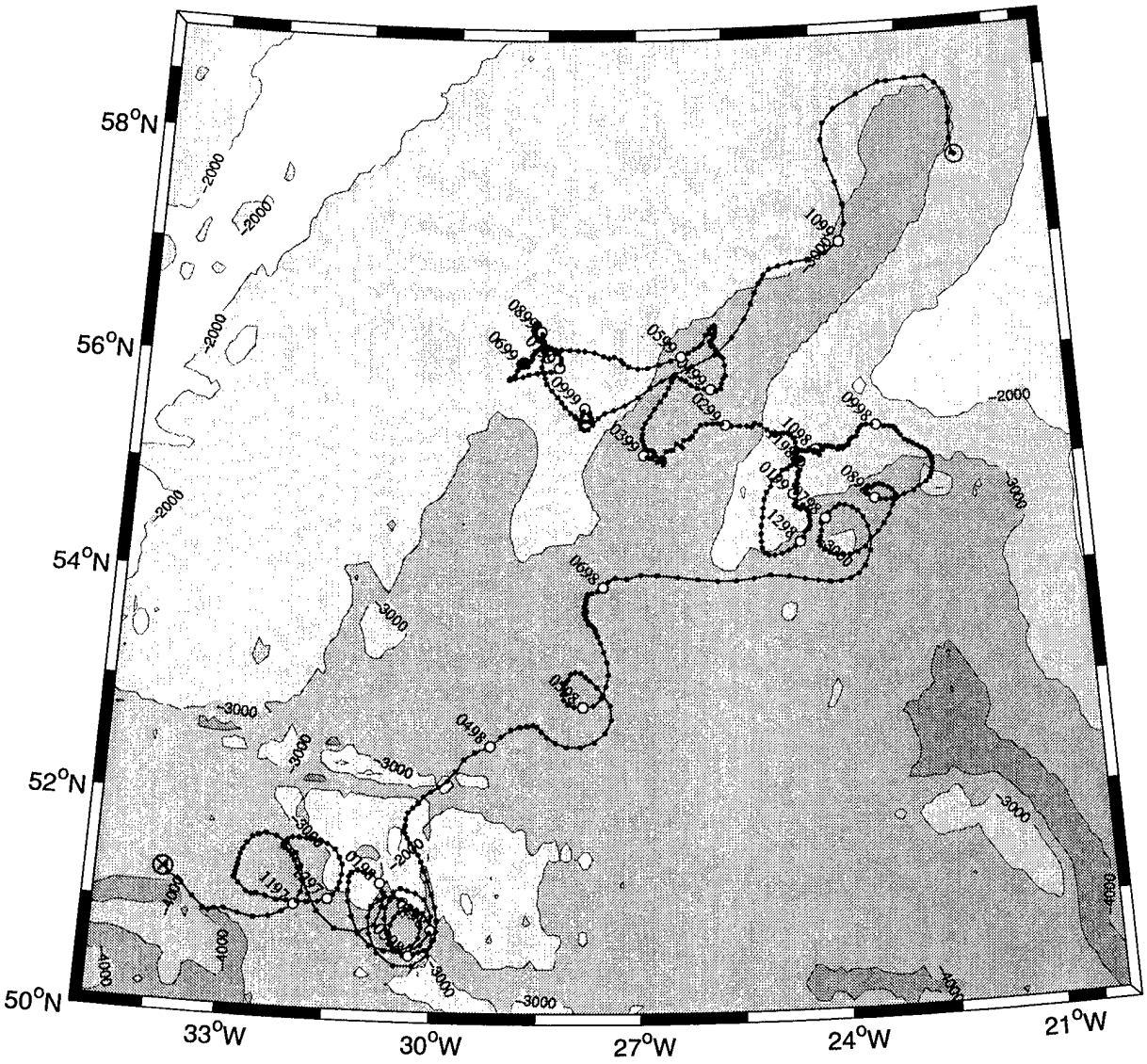

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
pressure (db)
u-velocity (cm/s)
v-velocity (cm/s)
u-v velocity (cm/s)
float record

w427: 100% msgs, 20–day interp

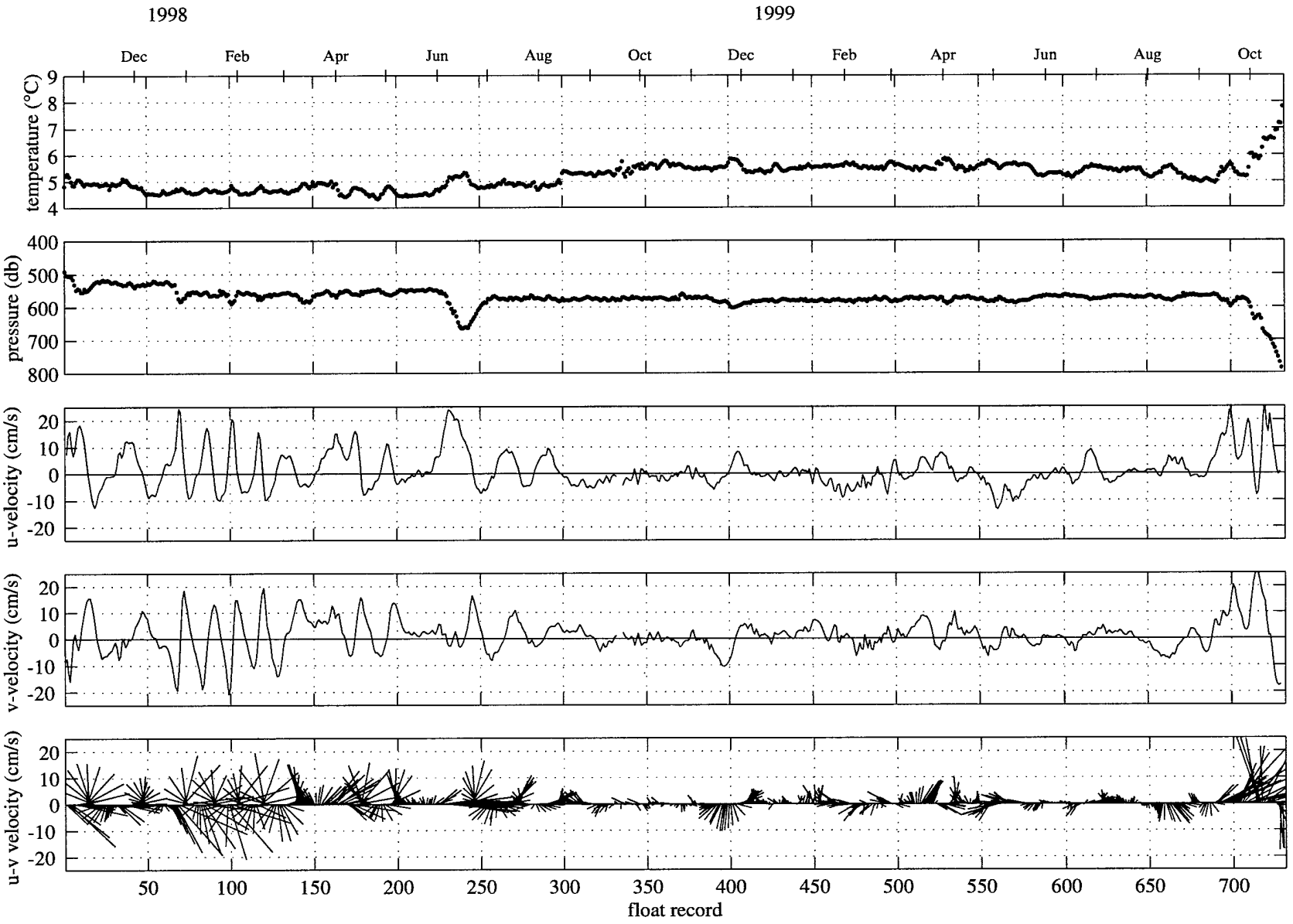



w427
1998
1999
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
temperature (°C)
pressure (db)
u-velocity (cm/s)
v-velocity (cm/s)
u-v velocity (cm/s)
float record

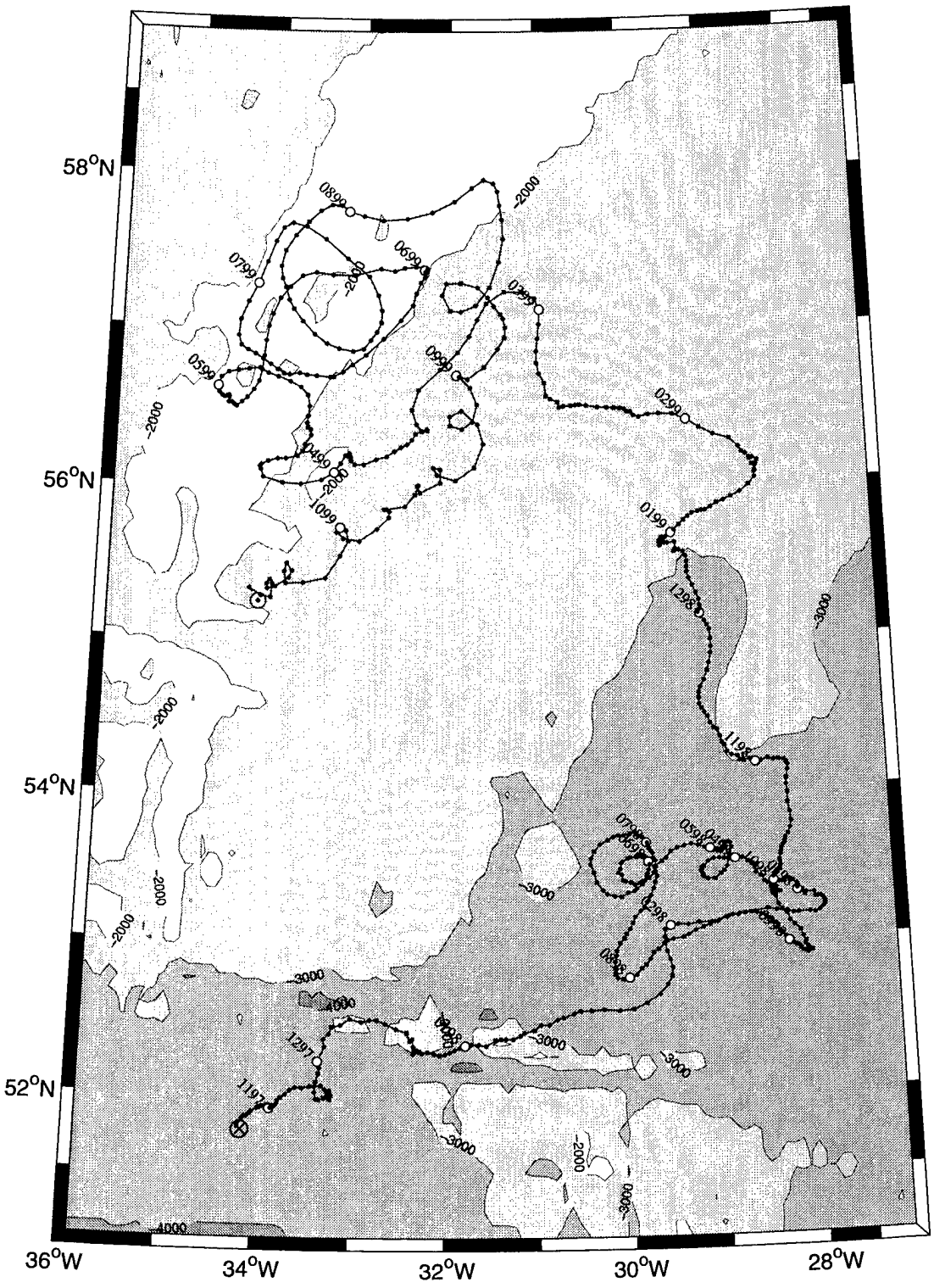
w428: 78% msgs, 10–day interp



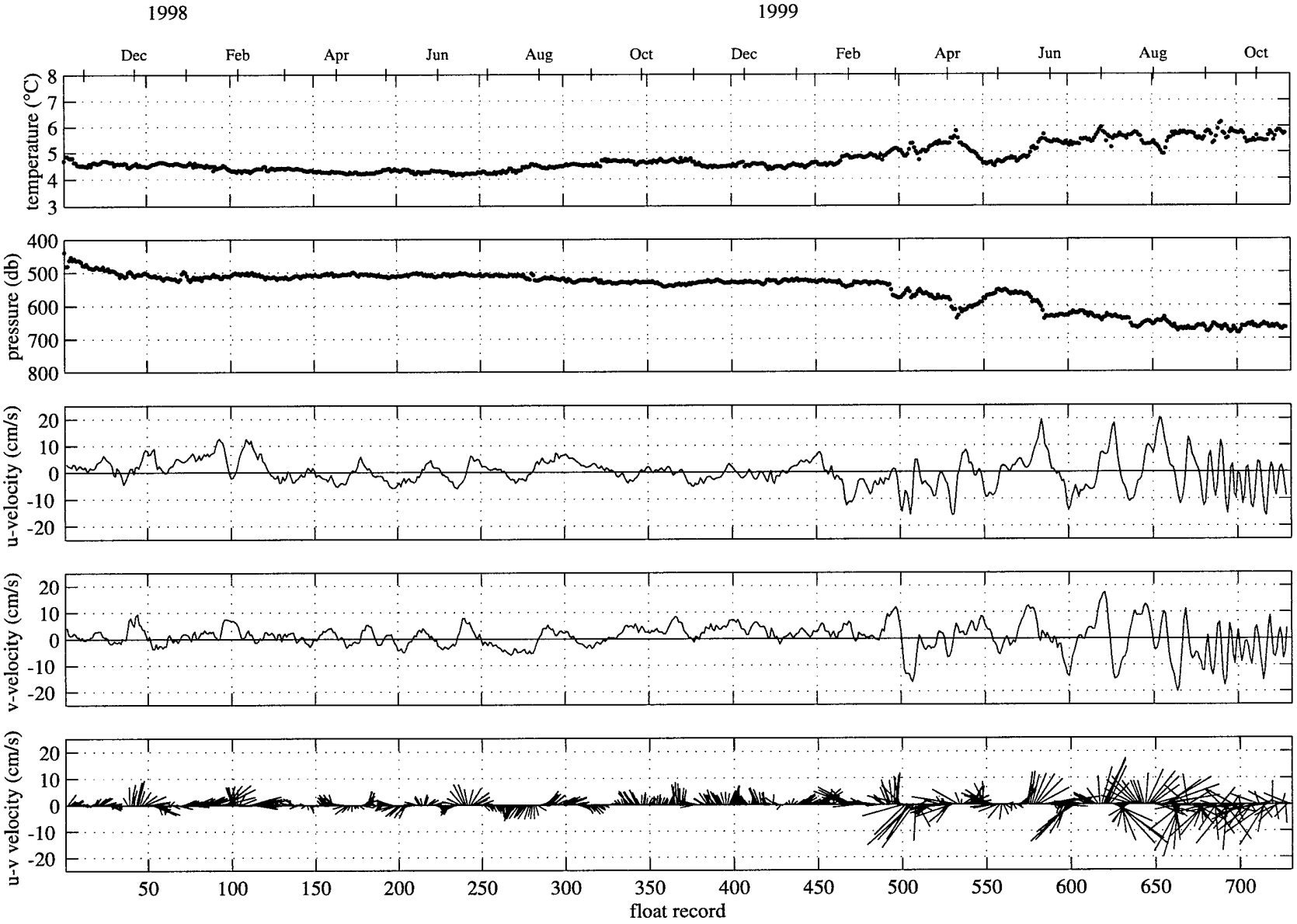
w428


1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
9
8
7
6
5
4
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

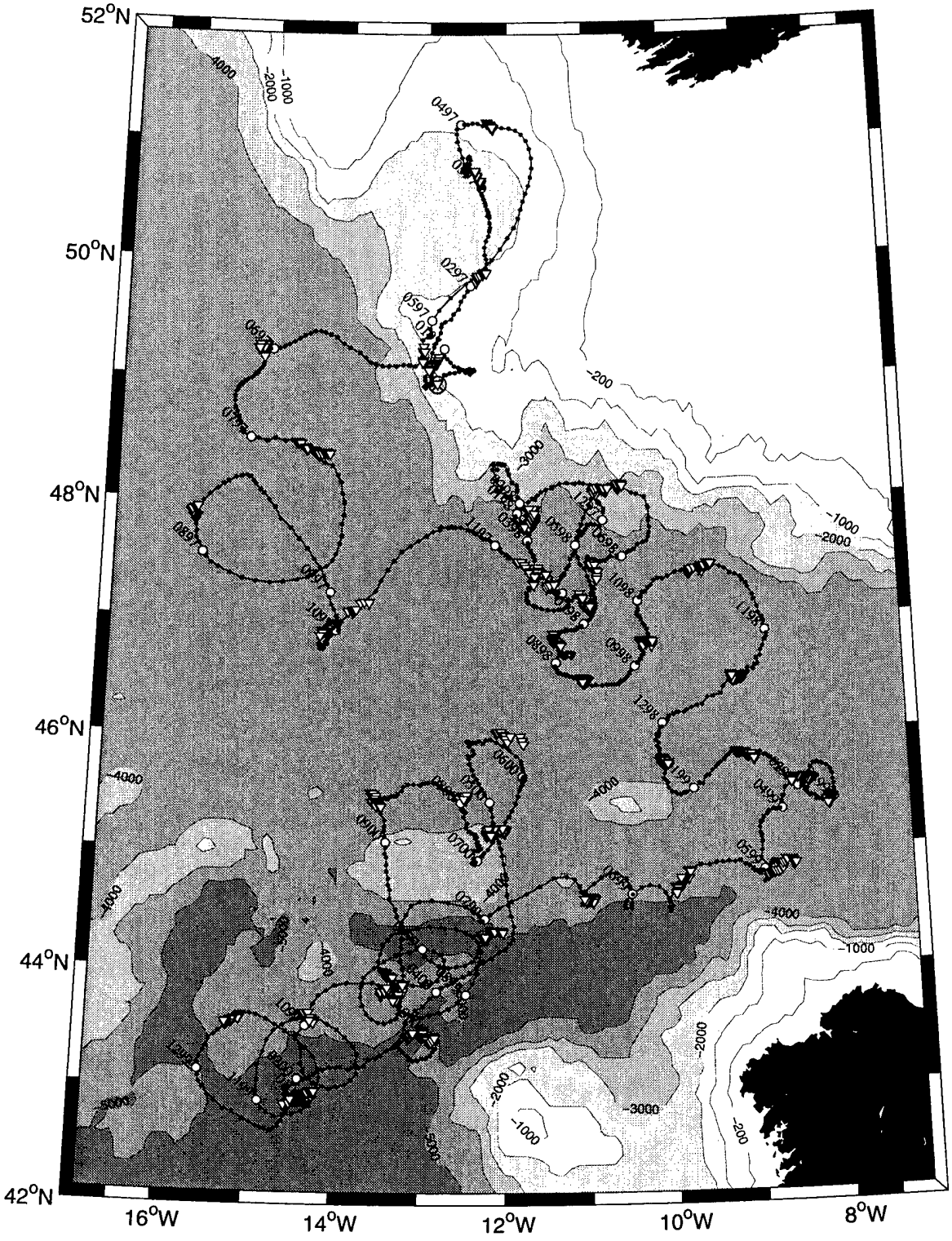
w429: 86% msgs, 10–day interp

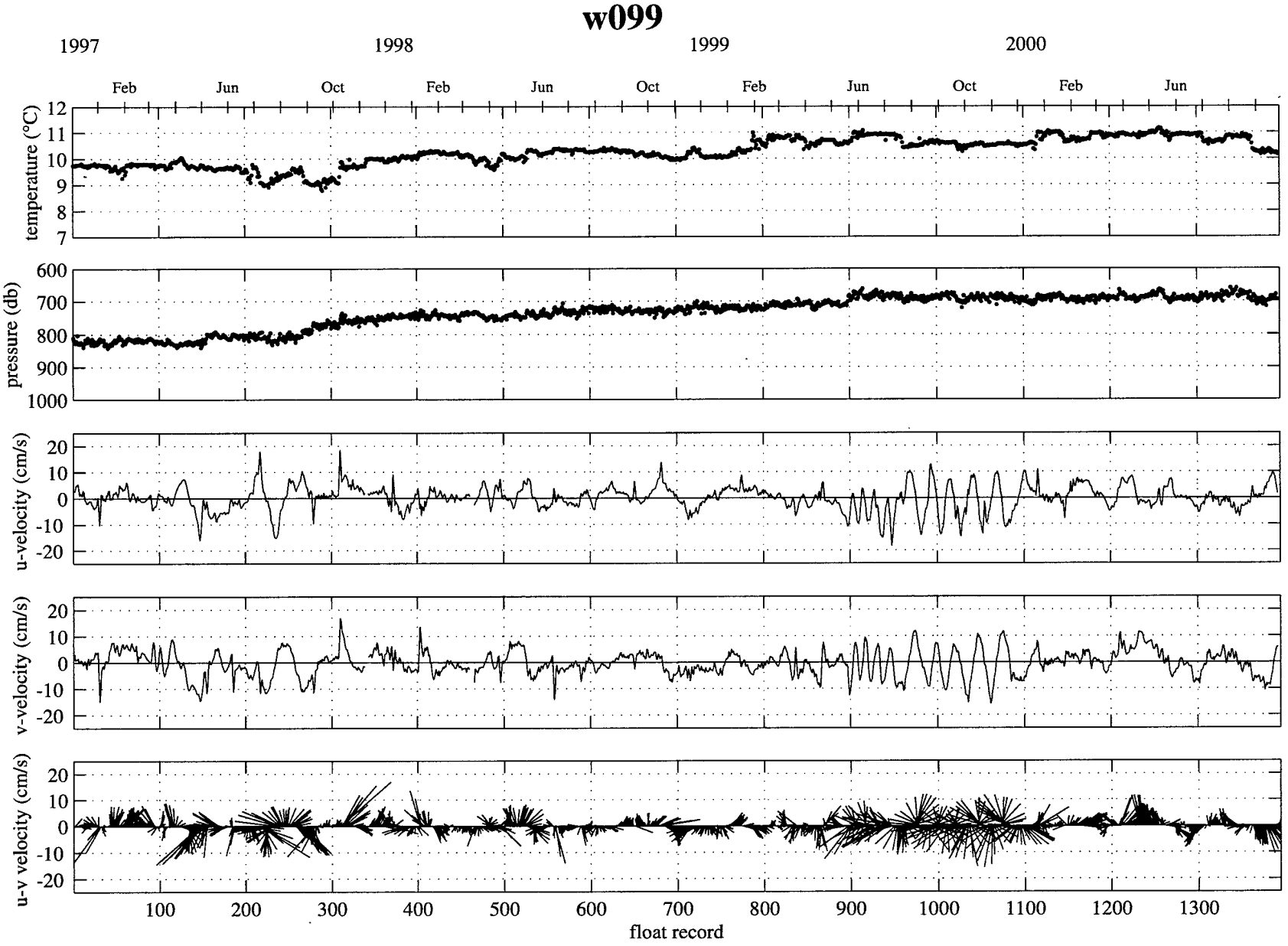


w429

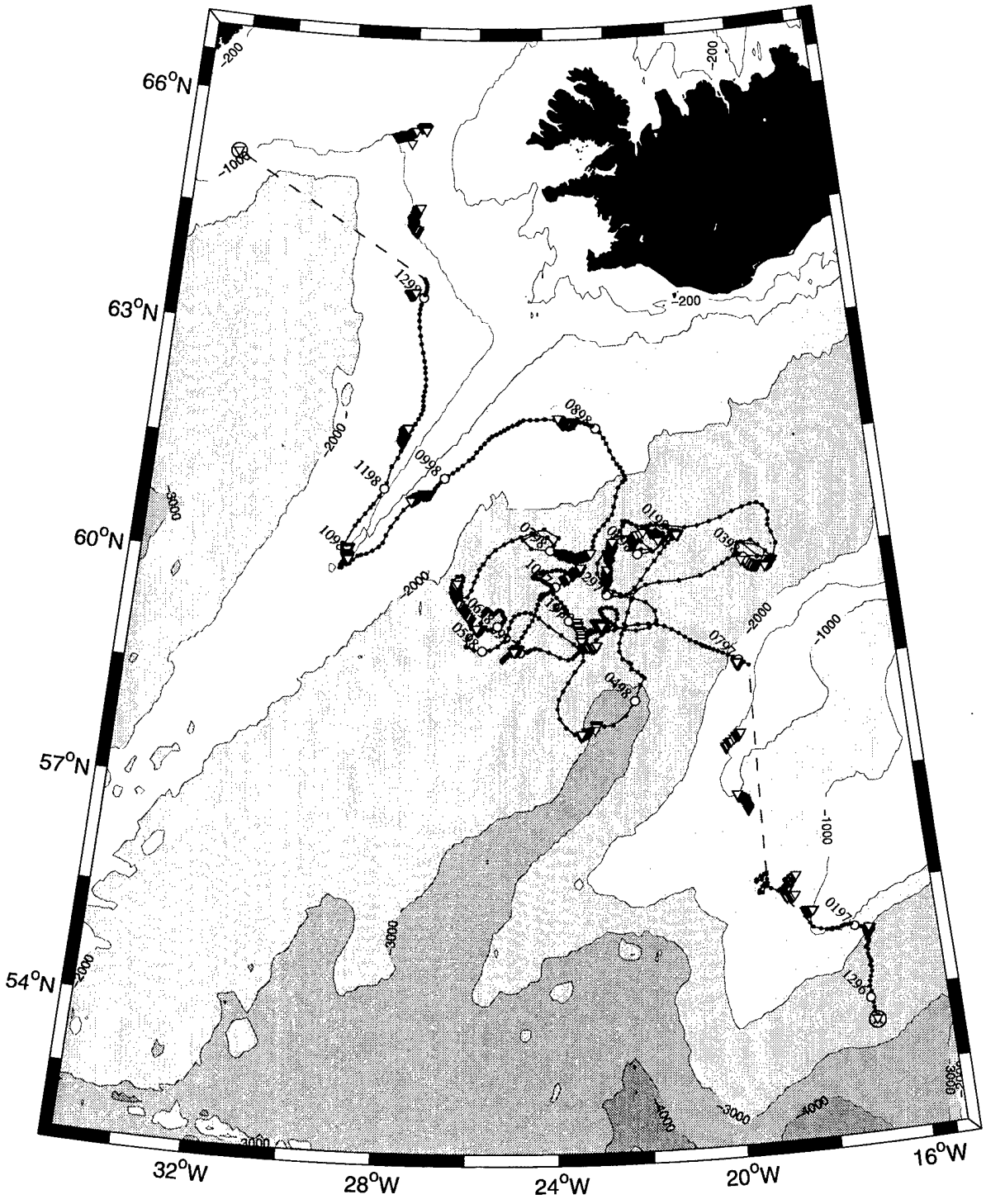

1998
1999
Dec
Feb
Apr
Jun
Aug
Oct
Dec
Feb
Apr
Jun
Aug
Oct
temperature (°C)
8
7
6
5
4
3
pressure (db)
400
500
600
700
800
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
50
100
150
200
250
300
350
400
450
500
550
600
650
700
float record

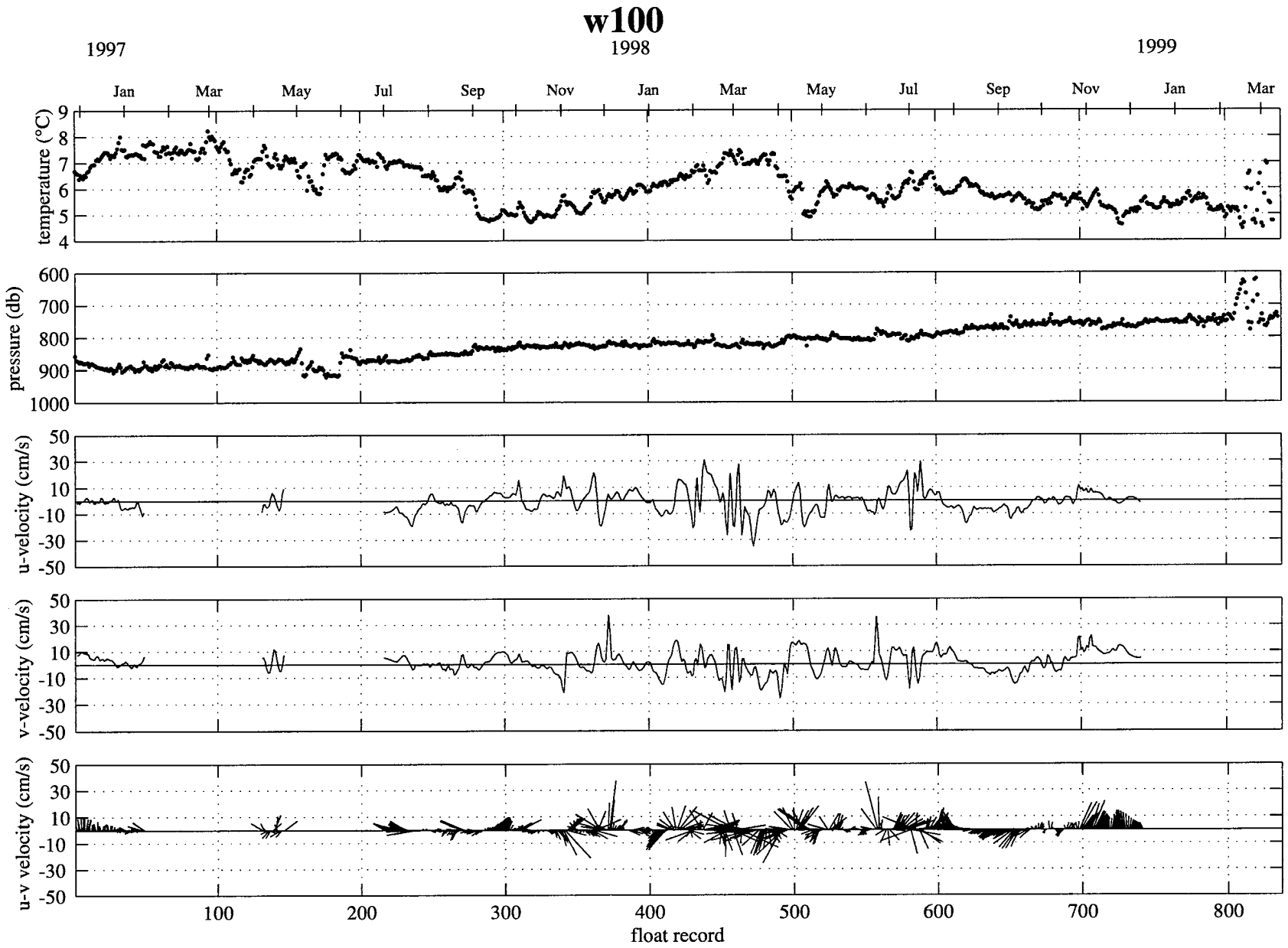
w099


52°N
50°N
48°N
46°N
44°N
42°N
16°W
14°W
12°W
10°W
8°W
-4000
-2000
-1000
-200
-3000


w099
1997
1998
1999
2000
Feb
Jun
Oct
Feb
Jun
Oct
Feb
Jun
Oct
Feb
Jun
temperature (°C)
12
11
10
9
8
7
pressure (db)
600
700
800
900
1000
u-velocity (cm/s)
20
10
0
-10
-20
v-velocity (cm/s)
20
10
0
-10
-20
u-v velocity (cm/s)
20
10
0
-10
-20
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
float record

w100


66°N
63°N
60°N
57°N
54°N
32°W
28°W
24°W
20°W
16°W
-200
-1000
-2000
-3000
-4000
1298
1198
0998
0898
0798
0598
0498
0197
1296


w100
1997
1998
1999
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
May
Jul
Sep
Nov
Jan
Mar
temperature (°C)
pressure (db)
u-velocity (cm/s)
v-velocity (cm/s)
u-v velocity (cm/s)
float record

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16. Abstract (Limit: 200 words)

This is the final data report of all acoustically tracked RAFOS float data collected by the Woods Hole Oceanographic Institution in 1996-1999 during the Atlantic Climate Change Experiment (ACCE). The RAFOS float component of ACCE, entitled "Warm Water Pathways and Intergyre Exchange in the Northeastern North Atlantic," was designed to measure the warm water currents entering the northeastern North Atlantic which become the source of intermediate and deep waters in the subpolar region. The experiment was comprised of three RAFOS float deployments on the R/V Knorr: the first in fall 1996 along the continental slope seaward of Porcupine Bank, the second in spring 1997 along the mid-Atlantic Ridge, and the final deployment in fall 1997 along both the Ridge and the Bank. Seventy floats were deployed, 13 RAFOS and 2 ALFOS in fall 1996, 14 RAFOS in spring 1997, and 41 RAFOS in fall 1997. The isobaric ALFOS floats were ballasted for 800 decibars and were launched to monitor the regions' sound sources during the experiment. The RAFOS floats were isopycnal and ballasted for the 27.5 sigma-t surface to target the intermediate-depth North Atlantic and Poleward Eastern Boundary Currents. The objectives of the Lagrangian float study were (1) to provide a quantitative description of the bifurcation of the North Atlantic Current east of the Mid-Atlantic Ridge, (2) to assess the importance of meridional eddy fluxes, compared to large-scale advection, in the northward flux of heat and salt in the northeastern North Atlantic, and (3) to establish the degree of continuity of the Poleward Eastern Boundary Current as it flows to the entrance of the Norwegian Sea and the fate of the Mediterranean Outflow Water carried by this current.

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subpolar region
floats

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c. COSATI Field/Group

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